SCHOOL SCIENCE EDUCATION IN INDIA

H.L. SHARMA

The book is based on the research study "A CRITICAL STUDY OF THE DEVELOPMENT OF SCHOOL SCIENCE EDUCATION IN INDIA FROM 1947-77", which is the first study of its kind. School Science has been of great concern since independence. To modernise it, a lot of energy, time and money have been spent. School Science Education in our country presents a diversity of problems and issues which need to be examined by all concerned.

The book reflects upon the various aspects of school science education in our country and attempts to provide information about the evolution and development of school science education in a chronological way. It mentions all landmarks, events and policies in the area of school science education which influenced the formulation, variations and changes that occured in it from time to time. Diametrically opposite changes in policy framework at times and the factors that played a part in the change process, have also been surveyed. As a background to the study, development of School Science education since 1500 A.D. to 1947 A.D. has been fairly attempted.

Not only this, the book reflects upon why certain innovations, succeeded as pilot projects and many socalled innovations that were introduced on the reported success in western countries could not be absorbed by our system. It also provides information about efforts made at Central level, State level and at Individual levels. Thus, the book serves useful purpose for researchers, policy makers, administrators, curriculum planners and science educators.

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SCHOOL SCIENCE EDUCATION IN INDIA

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Dedicated To The
Memory Of My Mother Smt. Kokila Devi
And Father Pandit Bhagwati Prashad Sharma 'Dayalu'

CONTENTS

PERFACE ix

1. Science and National Prosperity 1
2. Research Studies in School Science Education 13
3. Statement of Problem and Plan of Study 23
4. School Science Education During British Period 33
5. School Science Education During 1947-52 93
6. School Science Education During 1952-57 109
7. School Science Education During 1957-62 135
8. School Science Education During 1962-67 157
9. School Science Education During 1967-72 189
10. School Science Education During 1972-77 221
11. Summary and Conclusions 249

APPENDICES

A. Specimen Syllabus for Standard I 269

B. Topics for General Science Syllabus 273

C. Topics for Working Papers Prepared by UNESCO 277

D. The Main Recommendations of UNESCO Planning Mission's Report 279

E. Instructional Materials Produced under UNESCO-UNICEF Project (SEP) Middle and Secondary Stages upto 1972-73. 283

F. Position of Curriculum Materials Developed by the Study Groups in Physics, Chemistry, Biology and Mathematics as on 31st March, 1972. 289

INDEX 291

PREFACE

While serving in the Department of Science Education NCERT, the present investigator's major concern was to work on the school science curriculum. The investigator worked on different projects meant for improvement of school science education such as, UNESCO Aided Secondary School Science Teaching (SSST) project later on UNESCO-UNICEF Science Education Programme (SEP), Panels and Editorial Board's Project, Study Group Project, Equipment Development for the Summer Science Institutes (duplication of equipment-PSSC), development of instructional materials under 10+2 pattern of schooling (Environmental Studies for classes I-V, Integrated Courses for classes VI-VIII and Physics for classes IX and X).

A desire to study twists and turns in school science curriculum policy for Indian schools rose when the present investigator got an opportunity to be educated and oriented in different aspects of school science education at Lenin Pedagogical Institute, Moscow. Later it was desired to reflect upon why certain innovations succeeded as pilot projects and many so called innovations introduced on their reported success in western countries and some where else also could not be absorbed in our system and also to reflect upon the efforts made at Central State, Voluntary and individual levels because School Science has been of great concern in our country and to modernize it, a lot of energy, time and money has been spent on its development by these agencies. So it was planned to take up a research study to bring out development in the school science education. Knowing well that this type of research study would be a difficult task for an individual who was an insider he dared to study the evolution of school science education policy which has been a pivot for all programmes in the area of school science education. Aware of the famous dictum of Sir John Adams according to which present, being the darkest moment, can be evaluated only when it is dead and gone, yet the present investigator chose to make a modest effort to look back to initiate research in the area of development of school science education, in India.

The Study reflects upon the various aspect of school science education. It mentions all land marks, events and policies in the area of school science education from 1947 to 1977, which influenced the formulation, variations and changes that occured in it from time to time. Diametrically opposite changes in policy framework at times and the factors that played a part in this process have also been surveyed. The Study also attempts to provide an exhaustive and comprehensive information in the history of evolution and development of School Science education, in our country from 1500 A.D. to 1947 A.D.

The investigator places on record his heartfelt gratitude to his guide Dr. D. C. Joshi, Professor, (Education), Jamia Millia Islamia, New Delhi for all help to the investigator in conducting the study right from the time of registration to the preparation, and submission of the final report. The investigator is indebted to Professor Joshi also for his advice and guidance in the preparation of the book. The investigator is extremely grateful to his co-guide Dr. A.N. Bose, Professor (Science) for all help, guidance and allowing him to consult records and related documents, and also making him aware of many discussions regarding policy decisions and their implementation.

The present investigator is also grateful to Professor S. Shukla, for allowing him to share some of his insights, to Professor V.N. Wanchoo who has been a friend and philosopher and to Professor R. P. Singh without whose advice at the various stages of the study, the work could not have been completed and to many friends in NCERT in State Institutes of Science Education in States and Territories, SCERTs and staff members of Teachers' College Jamia Millia Islamia, staff members of Teachers' College Library, Zakir Hussain Library, NCERT Library, Central Secretariat Library, National Archives, Planning Commission Library, and National Institute of Educational Planning Administration and Library who helped the investigator. The Investigator wishes to express his gratitude to one and all who helped him directly or indirectly conductting this study.

In creating this book, the reports of the three examiness and comments of my friends who read thesis have helped me a lot for which my special thanks are due to them. I am grateful to the Educational Research and Innovations Committee (ERIC) of the National Council of Educational Research and Training (NCERT), New Delhi not only for their financial support in helping me meet part of the expenditure incurred in conducting the study but also meet part of the publication cost.

Whereas I am grateful to all these Scholars and institutions for their support, I cannot conclude my acknowledgements without expressing my gratitude to Sri Krishan Lal Verma of Common Wealth Publishers.

HARCHARAN LAL SHARMA

1

SCIENCE AND NATIONAL PROSPERITY

> The key to national prosperity, apart from the spirit of the people, lies in the modern age, in the effective combination of three factors, technology, raw materials and capital, of which the first is perhaps the most important, since the creation and adoption of new scientific techniques can, in fact, make up for deficiency in national resources, and reduce the demands on capital. But technology can only grow out of the study of science and its applications. (Government of India. 1958 Scientific Policy Resolution, par. 1)

The Scientific Policy Resolution (1958) correctly visualised the key role that science—its education and its application, had for our progress towards national prosperity and for securing minimum standard of living for our people. Indeed, the extent to which science and its application are used, makes a nation a developed or a developing nation. As pointed out by Kothari (1961), the prosperity and strength of a country directly depend on the level of scientific and technical knowledge cultivated in the country and on its capacity to make use of that knowledge to serve practical ends. (Presidential Address, p. 2)

So "science and technology must help to speedily improve production . . . science is both an outlook and a value system. . . . The task of creating a scientific temper is a vital necessity . . . for development." (Planning Commission. 1981. Sixth Five Year Plan, p. 320)

Thus, it is science and technology that determine the level of prosperity, welfare and security of nation. Science and its applications (technology) have made it possible for the developed nations to banish poverty, and to provide social and economic justice, and a standard of living to their people unmatched in their history. Those nations which could effectively utilise their scientific and technological manpower, raw-materials, and capital for their development could modernise themselves and in case of a shortage of raw-materials science and technology, make up for the deficiencies by providing substitutes and skills which could be exported in return for raw-materials, as it happened in the case of Japan.

So far manpower is concerned, more than three-fourths of our population still resides in the villages. Though we have made rapid strides towards industrialisation and modernisation of agriculture, we still need latest technology to contribute significantly to raise production in both the sectors. It is, therefore, of vital importance to us that knowledge and techniques discovered and perfected in various institutions of higher learning and research percolate down to the workers and farmers. To increase productivity, a farmer has to be informed about improved practices, better machines, storage techniques etc. as also about the scientific ways through which he can solve his day-to-day problems. Simultaneously, the workers need to be educated and trained for it is they who produce goods for competitive national and international markets. So, whatever is also true for agriculture and its allied industries, is also true for industry. Industry requires skilled workers such as Draftsman, Surveyors, Welders, Tractor Drivers, Machinists, Electricians, Pattern makers, Fitters, Turners, Carpenters, Overseers, etc. These unskilled and semi-skilled factory workers are by and large drawn from India's rural population. They can neither adjust and make necessary adjustments nor can they respond to new challenges effectively without proper education, particularly science education. Lack of education in science not only accounts for their low efficiency but also makes the task of modernising Indian industry difficult.

Content of Science

In fact, in all fields of planning, science plays a dominant and decisive role. All planning in agriculture, industry, community, health, environmental engineering, development of energy resources, population control, communication, transport, etc. which promises to secure a better quality of life for us, depends to a great extent on science and its education. Today no sector of human activity is untouched by the results of scientific thought. Modern society depends on the ideas and devices that emerge as a consequence of scientific knowledge.

Scientific knowledge grows constantly with new insights into events and phenomenon of nature and has developed at an ever-increasing pace since the beginning of this century. It has almost become an adage that what is put in print today is ipso facto out of date by the time it comes out in press. Due to this, the gap in generation and utilisation of scientific knowledge between the developed and developing nations has widened more and more which needs to be bridged. The gap can be bridged, as was pointed out by Nehru (1958) while addressing the parliament on the Scientific Policy Resolution "only by adopting the most vigorous measures and by putting forward our utmost effort into the development of science" (Nehru. 1958, Scientific Policy Resolution. par. 6), implying thereby the need for a continuous upgrading of content in science curriculum at all stages including school stage, where the 'destiny of India is being shaped. According to Indian Parliamentary and Scientific Committee (1964), "Science in our culture is a creative intellectual activity leading to unifying concepts of man's natural environment." (Report, p. 14). The prosperity of our society is now almost wholly dependent upon scientific cultural progress. Again, through the practical applications of scientific discovery our civilization and culture are undergoing change. "It is an inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably mankinds greatest enterprise today." (Nehru. op. cit., par. 6).

Method of Science

Again, science is not only a body of knowledge, it is also a way of thinking and doing, looking at things and events, an approach to learning as well as how to learn, and this applies equally to all area of intellectual enquiry. All disciplines of human learning are becoming now a days scientific. Be it the method of observation or of making symbolic, graphical or linguistic models or of designing experiments or of applying reason as well as imagination to draw conclusions from available sense-perception data, or the method of keeping an objective review while theories are tested, employ a method with which science works and which pervades every discipline. The 'Approach Paper' argues that "the facts of today may not be the facts of tomorrow, and theories may also undergo change but there can be no going away from the method of science. (NCERT. 1975. Curriculum for the Ten Year School. An Approach Paper, p. 15). Science is all pervasive.

Science Education and Scientific Temper

Not is this all. Science education is a powerful means of developing attitudes of critical enquiry, respect for truth, simplicity, adaptability and systematic work which are a pre-requisite for initiating the processes of social change and of national development. Science has introduced, as pointed out by Mahalanobis, a new concept of "Scientific or objective validity which has its foundations in nature itself and which can not be upset by any authority based on status or by super natural powers." (Mahalanobis. 1962. The Scientific Base of Economic Development. p. 14). This objective validity in itself implies scientific temper. In view of this it is necessary for every citizen to have basic education in sciences to enable him not only to appreciate the role and importance of science and its applications to modern technology, agriculture, industry, health, environment, etc., but also acquire scientific temper for his participatory roles in various areas of social action to participate in a democratic manner.

Perhaps, it is because of appreciation of science that led Nehru to constantly emphasise on development of scientific temper amongst our people as a pre-requisite for creating conditions necessary for an industrial revolution, and on this he was supported by eminent leaders, thinkers, educationists and scientists. And even today we stand by it. For instance, the Sixth Five Year Plan document observing Science and Technology as an essential and integral part of the development process reiterated that "science . . . should be made powerful force to eradicate old irrational attitude which has tend to hold back the nation from the path of progress." (Planning Commission. 1981. p. 320).

Science Education to All as well as for a Few

There are different views about the content of science education to be provided to all as well as for a few who will work in scientific and research organisations. Science education is needed for national development and contributions of people at various levels is required. As stated by National Man Power Council (1957), "the nation's economy and well-being and its continued progress depends to a striking degree upon a small group of men and women who are in scientific and professional fields" ('A Policy for Scientific and Professional Manpower'). Yet we can not ignore the masses from providing basic education in Science. On the other hand science education that is needed for scientific and professional excellence can not be provided to all due to obvious reasons. That is possible only for a few. Perhaps it may be because of this that Indira Gandhi (1975) had to emphasise that:

> No one can live intelligently in the world of today without understanding the facts and forces of science. In the days to come science will have a greater impact on our daily lives.

> It is important for children to extend their familiarity with various branches of science. Everyone should have a basic grasp, even though only a few will become specialists, (National Science Exhibition for Children, p. 1).

It appears that basic education in science should be of such a nature that can meet the need of all, in general, as well as be of such a quality that we are able to produce a few who will work in scientific and professional fields.

To sum up, the prosperity of our country, depends on the effective use of manpower which can be cultivated only by the study of science and its applications. This is so because the study of science and technology can alone provide for the use of our material resources in a meaningful way. A proper and well thought science education programme would help to inculcate those scientific and technical skills which are required for the development of our agriculture and industries. Even the scientific manpower needed for relevant research and its systematic application to agriculture, industry and other sectors of life can only come from a well planned system of science education right from the point a child enters the school.

Science in Indian Schools

The question arises: what kind of science and how its knowledge is to be imparted; the purpose being the prosperity of the country, inculcation of scientific temper and eradication of irrationality. In order to keep pace with modern science and technology, there is a need to include all that the world offers as well as the inherited scientific knowledge from our glorious past. In order to make country prosperous, which means the prosperity of backward sections of our society too, it appears that we have to make use of the latter in order to utilise the former. So we are to learn the space age science and technology and we have to keep in view our own innovations. Our school science education should be rooted in our cultural heritage, and on the other hand it has to keep itself in step with world trends. It is an inherent obligation of a great country like ours, with the traditions of scholarship and original thinking and its great cultural heritage, to formulate a plan for science education at all levels.

We have a long and distinguished tradition in science and technology, huge raw-materials and a suitable geographical climate and have inherited a glorious past. Yet our country is a developing country. It is a fact of history that during the ancient period mathematicians, astronomers, such as, Baudhayana, Garga, Medhatithi, Aryabhatta, Varahmihir, Brahmgupta and Bhaskara; scientists like Kanadi, Kapila, Umasvati, medical men such as, Dhanvantari, Bhardwaj, Attreya, Jivaka, Charaka, Susruta, Vagbhata; veterinary scientists like Solihotra; agriculturist like Khana; ship builders like Bhoja produced and preached significant scientific knowledge. This scientific knowledge, as pointed by Bernal (1948), "provided inspiration and knowledge, of sciences to the countries of the West through Arab countries where it was synthesised under the banner of Islam" (Science in History, p. 7). Perhaps, it was from this source that science and its techniques made a major impact upon thinkers of medieval Europe. There, it underwent a development which gave rise to modern science. As muslims came to India, the Arab knowledge was absorbed in Indian learning. New schools, Maktab and Madarasha came up side by side the prevalent Indian schools. The rulers of the time opened 'Karkhana' which provided apprenticeship for learning science and technology. Persons such as Aryabhatt II, Bhaskar, Nagarjun, Sheikh Abdullah, Sheikh Azizullah, Mir Fathullah Shirazi and Mulla Farid Munjajjim made significant contributions to scientific knowledge.

With the coming of European traders, medicine men and others, establishment of Calcutta Madarasha, the resolution of Charle's grant for introduction of western mechanical sciences, sanction of one lakh rupees for the introduction and promotion of knowledge of European literature and science, Macaulay's perception of a learned native as being one who knew Physics of Newton, the creation of Education Departments for the introduction of useful and practical knowledge suited to every station of life to the great mass of the people, making the

English as the medium of learning science in upper primary classes, the Indian Education Commission (1982-83)'s recommendation to introduce the elements of natural and physical science and their applications to agriculture, health and industrial arts right from primary level, Curzon's effort for improvement of science education in urban and rural schools, National Council of Education's efforts for inclusion of knowledge of the scientific truths embodied in oriental learning and medical education, Calcutta University Commission's recommendation for making science a compulsory subject, Abottwood's recommendation of relating school curriculum closely with the children's environment, Basic Education Scheme providing for teaching of General Science and the recommendation of Post war Educational Development Plan for making compulsory some knowledge of elementary science for all children were some of the efforts for school science education in our country before independence.

After independence there have been various attempts at reorganisation and expansion of education in general and science education in particular. The University Education Commission's recommendation for teaching of science right from primary school to the completion of undergraduate classes, the Secondary Education Commission's recommendation for introducing certain broad aspects of science-General Science at middle stage and also General Science for higher secondary stage, UNESCO Planning Mission's recommendations for teaching Physics and Biology from class VI, Physics, Biology and Chemistry in class VII and in VIII, Education Commission (1964-66)'s recommendations to teach Physics, Geology and Biology in Class V, Physics, Chemistry and Biology in Class VI and Physics, Biology, Chemistry and Astronomy in class VII, Ten year school curriculum expert group's recommendations for teaching science as Environmental Studies in primary classes and a flexible formula to develop integrated courses up to class VIII and also the grouping e.g., Physics and Chemistry, Physical Sciences, Life Sciences, Botany, Zoology and Human Physiology have been some of the efforts to improve school science education in our country after independence.

Thus it may be seen that number of attempts have been made towards improvement of science education in schools. Yet as pointed out by the Chairman, Atomic Energy Commission, Government of India that "over the years there have been a large number of conferences on science education and yet science education, *has not improved noticeably and in some respects one might even say that it has deteriorated.*," (Sethna, 1978. Key Note Address. p. 16). Similarly, Rozario and Gupte (1978) pointing to the "accepted fact that state of science teaching in our country is highly unsatisfactory", observed that one of the drawbacks "in science teaching in rural areas is the wide communication gap between the urban planners of school science curricula and the conditions prevailing in rural schools and common curriculum is designed for urban and rural students without taking into consideration the latter's environment" (Science Teaching Programme in Hoshangabad District, p. 202). It appears that there is something lacking somewhere, most probably in our school science education policy and to understand this, there is a need to study the development of school science education to reflect upon the status of school science education in our country which may help, as pointed out by Vaidya (1971), "evolving a worthwhile programme based on programmes already available which we can afford." (The Impact Science Teaching p. XIV).

However, to understand and reflect upon the development of school science education policies and programmes in India, it would be proper to look back and have a glance over the status of school science education during the different periods of our history, so as to map out the various stages through which these policies and programmes have evolved and thus better appreciate the evolution of present school science policies and programmes and the problems that history has bequethed us.

Before taking up the periodical reviews, it would be better to review the researches done in the area of school science education which forms the second chapter of the study.

REFERENCES

Bernal, J.D. 1948, *Science in History*, London: Watts, 40, Drury Lane, W. C. 2. (second edition—1957).

Department of Science and Technology, 1979, *National Paper, Conference in Science and Technology for Development*. New Delhi: Department of Science and Technology (Government of India).

Education Commission (1964-66). 1966, *Education and National Development*, New Delhi: Government of India (Reprint by NCERT, New Delhi-16 Edition 1971, p. 769).

Government of India, 1958, Scientific Policy Resolution (4 March, 1958) in *Department of Science and Technology 1979*).

Homi Bhabha Centre for Science Education, 1978. *Proceedings of the Conference on Science Education*. Bombay: TIFR.

Indira Gandhi, 1975, *National Science Exhibition for Children*. New Delhi: Jawaharlal Nehru Memorial Fund and NCERT.

Indian Parliamentary and Scientific Committee, 1964, *Report-Science Education in Schools*. Government of India: Reprint Edition (1965) NCERT.

Kothari, D.S. 1961, Presidential Address—Some Problems in Secondary Science Education. Sixth Annual Conference of All India Science Teacher's Association. *Vigyan Shikshak*, *Vol. VI*, *No. 1*, (1962).

Mahalanobis, P. C. 1962. The Scientific Base of Economic Development in (*Position of Science Teaching in Indian Schools. A Factual Report, NCERT.*)

NCERT (National Council of Educational Research and Training), 1975, *The Curriculum for the Ten Year School—An Approach Paper*. New Delhi: NCERT.

National Man Power Council. 1957, A Policy for Scientific and Professional Manpower. Columbia University Press. *in Vigyan Shikshak Vol. IV. No. 4 (1960), p. 5.*

Nehru, Jawaharlal, 1958, Statement in Parliament on the Scientific Policy Resolution (1958), in (*Education Commission* (*1964-66*). *1966.*

Planning Commission, 1981, *Sixth Five Year Plan*, New Delhi: Government of India.

Rozario, Rexd and Gupte. A.P. 1978, Science Teaching Programme in Hoshangabad District in (*Homi Bhabha Centre for Science Education, 1978*).

Sethna, H. N. 1978, Key Note Address in (*Homi Bhabha Centre for Science Education, 1978*).

Vaidya, N. 1971, *The Impact Science Teaching*, New Delhi: Oxford and IBH Publishing Co.

2

RESEARCH STUDIES IN SCHOOL SCIENCE EDUCATION

> Meagre attention has been paid to research in the area of science education . . . whatever research has been done in general is unplanned and perhaps, not directly and functionally relevant and as such has not made significant impact on science education in this country (Bose et. al., 1983. Study on Position of Science Education in India. p. 71).

The 'Study on Position of Science Education in India' (1983) correctly assessed that "State of research in Science Education in our country has not been encouraging. It has almost remained restricted to the areas of instructional materials, methodology of teaching, resources and facilities available in schools for teaching science. (Report 1983, p. 67) One of the main reasons for such poor shape of research related to science education in our country, as pointed out in 'Study on Position of Science Education India' 1983, is the non-existence of separate department of science education in any University in India. In most of the Indian universities except a few such as, Aligarh Muslim University and Poona University, all research work in science education at Ph.D. level is conducted under the Faculty of Education—which are by and large dominated by persons who have little or no backround of science and lesser still any interest in science education. (Report, p. 68).

About forty persons were working in all the Universities, teacher training colleges and other research centres in science education as a minor part-time activity. This may be one of the reasons to pay a minor attention to this area. (Wanchoo, 1977. Some Current Issues in Science Education, p. 3). Another reason might be that "a large scale planned effort for the improvement of school science in India was of comparatively recent origin." (Joshi. 1965, Progress of Science Education Since Independence, p. 2).

Educational Researches in Science Education

Research in science education has a short history in our country. As pointed out by Yadav and Menon (1979), "educational research is of recent origin in India." (Educational Research—A Perspective, p. 7). The first study in school science education was done by Kelkar (1950) who conducted a study to present a tentative course of study in general science for the secondary school of the province of Bombay and to discuss the historical and philosophical background of the new course of study in general science. The sample consisted of high school pupils of both sexes in the city of Belgaun. The important findings were that high school pupils were more interested in science than in any other subject, boys were more interested in science than girls, pupil's interest in science decreased as the course advanced, the interest was evenly divided between Biological and Physical Sciences, there was no significant sex difference in the distribution of pupil's scientific interest between the Biological and Physical Sciences. Health and Physiology, Plant life, Animal life and Astronomy dominated the scientific interests of pupils of both sexes at the high school stage. Soil, Bacteria, Air, Sound and Water were the topics in which, high school pupils showed the least interest and were more interested in the fundamentals of science than in its practical application. Kelkar suggested a course in general science consisting of ten units, each of which represented some major problems of living a wide area of human experience or an important aspect of environment. (A Tentative Course of Study in General Science for the S. S. C. Examination, p. 284).

After a decade, Veerappa (1958), conducted a study of trends in science education from primary to the degree course level with a purpose to study the existing position of science education in India and to assess the new trends in the field, keeping in view the trends of science education in some of the developed countries like U.S.A., U.K. In order to acquire a correct understanding of the British secondary education system, institutions in different parts of U.K. were also selected. Some of the major findings of his study throwing light on science teaching at different levels were:

- —science education is introduced at the primary level and that general science has replaced nature study.
- —the science course mainly consists of topics like food, air, water, atmosphere and environment etc.
- —general science course at primary level has not been very popular due to lack of qualified teachers.
- —the courses in secondary schools generally include physics, chemistry and biology.
- —only a few schools (four) have science clubs.
- —examination papers are generally loaded with essay type questions.
- —equipment in the laboratories is either inadequate or of poor quality (Trends in Science Education, p. 302).

Veerappa concluded that due to want of proper laboratories, well-trained science teachers and effective teaching methods—science education in India was not on a proper footing.

Patole (1967) explored the existing weakness of teaching science in rural primary schools of rural areas in Kolhapur district, some of the weaknesses being lack of science apparatus, lack of science room, lack of funds to prepare aids and even lack of reference books in the school library to get more scientific information, lack of qualified leaders, lack of consultants etc., and concluded that "science teaching in rural primary schools was dull and dry." Regarding interests of children in science, some findings were:

—There seems no significant difference in the boys and girls as regards interests in science.

—Pupil's interests in science decreases as they grow up.

—The areas dominating the interests of rural pupils in their descending order being human body, machine, weather, plant life, animal life.

—The topics in which pupils seem most interested being our body, health and hygiene, mechanics, diseases, heat, senses, air, water and food for plants.

—The topics in which pupils showed less interests being—pest in plants, seasons, insects, fishes, other animals, reproductions of human beings.

Patole found that activity-based method of teaching the subject was superior to traditional one (A Study of Teaching Science in Rural Primary Schools). The Third Indian Year Book of Education—Educational Research (1968), gave a status report on educational researches in different areas of education. Though it was a first book of educational research, no attempt was made to survey the researches in the field of science education. Ghosh and Gupta (1968) while reviewing the researches in 'curriculum' observed that "educational research developed in India only recently and whatever researches were done since 1939, curriculum was a very neglected area." (Curriculum, p. 48).

Ghosal (1973) studied the curricular trends in secondary education in India during British rule, in the context of development in England. He found that secondary school in India had failed to come up to expectations for the simple reason that its curriculum was an immitation of the British model without proper consideration of the social, economic or cultural context of the nation. He further concluded that Indian Secondary

Education at the end of the British rule was much the same as it was in 1904 and had changed a little from what it was in 1884, the reformers of Indian Education studied foreign system of education and tried to derive benefit from it which resulted into a system unsuitable to the Indian situation. (An Enquiry into the Curricular Trend in the Secondary Schools of India during British Rule, p. 277). Desai and Roy (1974) presented a review of studies on curriculum, methods and textbooks based on the sixty-nine studies at Ph.D. level in the entire field of education and found that "research in curriculum did not exist." (Curriculum, Methods and Text Books, p. 264). According to them against the background of curriculum developments in the advanced countries, in India it was narrowly conceived, and urgently needed fundamental research to be executed to provide empirical foundations for curricular change.

The present investigator conducted a survey of researches in science and mathematics education done during the period 1939-1974 in India, with a view to locate gaps and to evolve procedure for development of research in these two subjects, in NCERT, in State Institutes of Science Education, in universities and in other agencies and finally to disseminate information so as to reach the consumer. Three hundred and ninety three research studies done at M.Ed. and Ph.D. level were classified into twelve areas. It was surprising to note that out of total three hundred and ninetythree studies done at M.Ed. and Ph.D. level only two studies were reported at Ph.D. level. However, out of these three hundred and ninety three studies there were one hundred fiftysix studies in the area of examination, evaluation, achievement tests etc., sixtytwo studies in the area of syllabus including curriculum, twentyeight studies in the area of individual subjects (Physics, Chemistry, Biology etc.), twenty five studies in the area of methods of teaching science, nineteen studies in the area of text-books, eighteen studies in the area of integration of science teaching, with other subjects, seventeen studies in the area of pupils of science, sixteen studies in the area of interests of children, fifteen studies in the area of audio-visual aids, fourteen studies in the area of science teachers, twelve studies in the area of facilities for science teaching, nine studies in the area of science clubs, fairs, (Sharma, H.L. 1974). This work was further surveyed at Trivandrum and again at Amritsar. A critical report of the study was prepared. (Wanchoo and Sharma, 1975, p. 314). The whole work was reviewed once again at Regional College of Education, Ajmer. The studies were again reclassified under six major areas—science curriculum being one of the area. Science curriculum was classified in the sub-areas as follows:

Sl. No.	*Sub Area*	*Frequency*	
		M. Ed.	Ph. D.
1.	Development of syllabus for criteria for the development of curriculum	17	1
2.	Scope of science syllabus	13	
3.	Place of science in the school curriculum	2	
4.	Historical studies on science curriculum development	1	
5.	Science curriculum enrichment programmes	1	
6.	Trends in science curriculum	—	1
		34	2

These thirty-four studies undertaken at M.Ed. level, as pointed out by Wanchoo and Raina (1976), lacked a theoretical base and no rationale was formulated for the development or evaluation of science curricula. Researchers used the instruments prepared by themselves. The attempt was not significant. (Research in Science and Mathematics Education, p. 29).

Not only at Universities, Training Colleges, but also at NCERT, SCERTs, and State Institute of Science Education basic research work in school science education has recieved little attention. Wanchoo (1977) coroborated this fact, while discuss-the current issues in Science Education, (op. cit., p. 8). Vaidya and Rajput (1977) too observed:

> It won't be far wrong to say that the whole area of research in science education right through out the school is open for investigation. Studies are urgently required in the following areas: history and philosophy of science education alongwith their implications for curriculum development, factual survey of facilities for science teaching, curriculum construction, development and evaluation (school programmes) effectiveness of science laboratories . . . the training and professional growth of science teachers . . . (Reshaping our school science education, p. xx).

Similarly, Roy (1979), while writing 'A Trend Report' also observed that "science claimed significantly fewer studies. These studies concerned themselves mainly with the trend course of science." (Curriculum, Methods and Text books, p. 280) Shukla (1979), too, pointed out that "a very small amount of attention has been paid to the history of the development of pedagogy." (History of Education, p. 39). Areas such as, history of development of curriculum, school practices, or educational theory or institutions had not been attempted.

Thus, the survey of work done in the area of science education reveals that there is a paucity of studies which deal with the history of science education indicating its implications for curriculum development which, as pointed out by Vaidya and Rajput (1977), "is urgently required." It appears that it may be a worthwhile proposition to study the development of school science education policy and factors affecting its implementation for curriculum development which hopefully may, meet this need.

To sum up, it appears that a thorough investigation ought to be made into the development of school science education policy and factors affecting its implementation for curriculum development to help evolving a well-thought and relevant school science education programme. Only a critical study of relevant documents relating to school science education during the post-independence era could help one to reflect upon the state of school science education in our country.

REFERENCES

Bose, A. N. *et. al.*, 1983, ***Study on Position of Science Education in India***, New Delhi: NCERT (DESM).

Buch, M. B. (Ed.) 1974, ***A Survey of Research in Education***, Baroda: Centre of Advanced Study in Education—M.S. University.

Buch M. B. (Ed.), 1979, ***Second Survey of Research in Education.*** Baroda: Society for Educational Research and Development.

Desai, D. B. and Roy, S. 1974, Curriculum, Methods and Textbooks in (*Buch, M. B. (Ed.) 1974*).

Gosh, B. and Gupta, L. N. (1968), Curriculum in (*The Third Indian Year Book of Education—Educational Research*, New Delhi: NCERT).

Ghosal, T. 1973. An Inquiry into the Curricular Trend in the Secondary Schools of India during the British Rule—A Critical Study and Comparative Study—Ph. D. Thesis—Calcutta University in (*Buch, M. B. (Ed.)*. (1979).

Joshi, A. C. 1965, Progress of Science Education Since Independence in (*Vigyan Shfkshak*, Vol. X. No. 1. New Delhi; All India Science Teachers Association).

Kelkar, S. V. 1959. A Tentative Course of Study in General Science for the S. S. C. Examination—Ph. D. Thesis, Bombay University in (*Buch, M.B. (Ed.), (1974*).

Patole, N K. 1967, ***A Study of Teaching Science in Rural Primary Schools***, (Standards I to VII)—Ph. D. Thesis, University of Poona. (Unpublished)

Roy, S. 1979, Curriculum, Methods and Textbooks in (*Buch. M.B. (Ed.), 1979*).

Sharma, H. L. 1974, ***Survey of Research in Science and Mathematics Education***. New Delhi: Department of Education in Science and Mathematics (NCERT). Unpublished.

Shukla, S. 1979, History of Education—A Trend Report. in (*Buch M.B. (Ed.)*, 1979).

Vaidya, N. and Rajput, J. S. (Ed.), 1977. Introduction, *Reshaping our School Science Education. New Delhi*: Oxford and IBH Publishing Co.

Veerappa, N. S. 1958, Trends in Science Education. D.Ed. Education, Mysore University in (*Buch. M.B. (Ed.), 1974*).

Wanchoo, V. N. 1977. Some Current Issues in Science Education in (*Vaidya, N. and Rajput, J. S. (Ed.) 1977*).

Wanchoo, V. N. and Raina, T. N. (Ed.), 1976, *Research in Science and Mathmatics Education*. Ajmer: Regional College of Education.

Wanchoo, V. N. and Sharma, H. L. 1975. Survey and Development of Research in Science and Mathematics Education in (*Buch, M. B.* (*Ed.*), *1979*).

Yadav, M. S. and Menon, M.B. 1979, Educational Research—A Perspective in (*Buch, M.B.* (*Ed.*), *1979*).

Raina, K. N., 1960, *Research in School Science* in (Vigyan Shikshak Vol. IV. No. 1 pp. 22-24).

Sharma, G. N. 1973, *An Investigation with Supervisory Technique in Science* (*Physics*) *Teaching in Higher Secondary Classes in Delhi Schools*—Ph. D. Thesis Delhi University.

Sumathykutty Amma, N. 1973, *Science Interests in High School Pupils in Kerala and Factors Contributing to the Development of these Interests*—Ph. D. Thesis Kerala University.

Wanchoo, V. N. 1977, Research in Science Education at College and School Levels. *Vigyan Shikshak*, Vol. 22 No. 3, pp. 1-12.

16447

3

STATEMENT OF PROBLEM AND PLAN OF STUDY

> The modern science, as we know today and our children learn in our educational institutions, is essentially an import from the western world. True, advanced scientific knowledge existed in India even before we knew the West. Techonology too was well advanced as evident from the archeological findings which leave us baffled about the sort of society that existed in those times. Nevertheless, the science instruction did not exist in our educational institutions before the British system of education came to India. . . .
>
> In terms of number, the country can now boast to have a large scientific manpower, statistically the third in the world. In qualitative terms the Indian science does not compare well with many western countries. . . .
>
> It is well accepted that the fault lies with the science curriculum followed so far. It has remained modelled after the foreign systems and has remained unconcerned with the Indian realities, (Mishra, 1983, pp. 8-9).

School Science Education, as discussed in earlier chapters, in our country presents a diversity of problems and issues which demand specific diagnosis and solutions by the country's education policy makers and professionls in science education. As pointed out earlier, for our economic development, national prosperity and emergence of democratic institutional processes, the need for a proper school science education is obvious. If our country is to attain its rightful place in the comity of nation and utilise its unique potentialities, we need education in science and technology. Inspite of the fact that we have been grappling with the problem of evolving a relevant school science policy and its implementation we have not succeeded in solving it. As pointed out by Sethana, "Science education has not improved noticeably and in some respects one might even say that it has deteriorated."

A survey of research work done in the area of school science education revealed that little attention has been paid to the problem of school science education policy. About eight studies on science education are available at Ph.D. level in the country. These have centred around course content, instructional materials, methodology of teaching style, scientific interests of pupils and scholastic achievment in science. There has been no effort to look at school education policies which could throw some light on the present state of science education programmes and provide some pointers for future.

It is generally agreed that school science education must ultimately lead to its impact for the good of society. The impact of school science education, not only must lead to greater production of goods and services (Science, technology and productivity), but also inculcate scientific temper amongst our people for building up a just and democratic society. This work should begin from the very beginning i.e., from the school stage. It is also an agreed fact that school science education must ultimately turnout students who would, with further specialised training provide the country with skilled man-power for Industries, Agriculture, Health, Trade, Commerce, Research and Development and other spheres of economy where knowledge of science is a prerequisite. If this be so, then it is pertinent to enquire whether school science policy has led to a system which can effectively fulfil its responsibility to turn out future citizens equipped with necessary knowledge of science and technology.

Such a school science programme will have to meet the challenges of formulating achievable objectives, of providing relevant content, of devising effective teaching methods, of proper preparation of teachers and establishment of institutions and organizations to monitor, to coordinate and to implement it effectively. In brief, the task is of planning a well thought out and relevant school science education programme within the existing or emerging structure of the education system.

In India, School Science Education is financed by the Government, Central or State, or local bodies. According to Fourth All India Educational Survey, out of a total of 4,74,636 primary schools 93.99 per cent were managed by Government or Local bodies such as Municipal Corporation, and Parishads. Out of total number of middle schools (1,12,404), 40.31 per cent schools were managed by the Government, 38.13 per cent were magaged by Local bodies. Thus, 78.44 per cent of the middle schools were either run by Government or Local bodies. (NCERT, Fourth Education Survey, pp. 20-21). Even the privately managed schools which are run by societies or individuals getting grant or no grant from the Government, follow the curriculum laid down by the States. Upto the middle stage the State Governments through their Departments of Education prescribe the courses, textbooks, teaching methodology and evaluation procedure. The policy is determined by the State. At the secondary level, all schools whether government, local body, private aided or private unaided schools are controlled academically by Board of Secondary Education of the States or Central Board of Secondary Education which determine the syllabus for examinations. Therefore, it may be concluded that school science policy is, by and large, State Science Education Policy.

What is policy? Policy may be the reflection of the ideology propounded by an individual, propogated by a group or adopted by a social system which considers it fit for sustaining that system.

On the other hand, there may be many factors which influence an individual or groups or a society to frame its educational policies. It is very difficult to list all these factors. However, thoughts and ideas of great thinkers, vested interests of power groups within the social (state) institutions which singly or in combination influence policy decisions, or in case of modern democratic social systems it may just be policy statements of the party which might be in power, influences policy decisions. For instance, in case of India, centuries of foreign rule left the country in a state from where even the expectation of a minimum standard of living appeared a target extremely difficult to achieve. Given the state of resource mobilisation, cultivation of human talent was the major factor that the country could be led towards a better future. For this, it was only through policy planning at all levels of the educational system that the gap between human efficiency and the required resource mobilisation could be filled.

Going by University Education Report (1948), the First Five Year Plan (1951-56) and Secondary Education Commission (1954) it appears that we were aware of it. But looking back, much of which the present investigator intends to do in the next few chapters, it appears that policy planning with reference to education has not grown in totality. It has been through stages and in pieces. How have been our school sceince educational policies evolved ? Though there are more or less set procedures to evolve a policy proposal—the way it is made, checked and examined at different stages, going through different committees for approval, and finally by the government to declare it as a policy, yet, as pointed out by Singh (1963), "too much of our educational planning and policy making has been the result of individual judgements, not always well informed." (Emergency Problems in Indian Education, p. 19).

The success of a policy is seen in its implementation. In implementation of a policy, there are again many factors which influence its implementation and it is difficult to list all these factors. However, some significant ones may be Time Constant, Suitability of Instructional Materials, Coordination Amongst Various Agencies, Variations in School Structure etc. As far as time-constant is concerned it has to be noted that the educational process is a slow process. Changes in educational policy take time to reach the class-room programmes. Obviously, frequent changes may hamper the tempo once gained to implement the programme decided upon according to a policy, wherein many agencies and factors are involved. Consistency in framing and implementing policies may prove fruitful. A consistent and sustained effort obviously seems necessary to achieve results. A Chinese proverb goes, 'if you are planning for one year plant grain, if you are planning for ten years plant trees, and if you are planning for a hundred years plant men'.

So if manpower is to be planned and nurtured through a proper education policy particularly science education policy not only to achieve self-sufficiency in all sectors of national development but for adjustment in a democratic society too, time-constant will have to be taken into account. To establish a minimum base for scientific research as pointed out by Mahalanobis (1962), "there is need of a time constant which may be twenty-five or thirty years" (The Scientific Base for Economic Development). A time constant is more needed to see the effect of an educational policy once put for implementation. Sarabhai (1967), while addressing the meeting of Central Advisory Board of Education (CABE) observed that "education is a process which as everyone knows here, is not something which occurs in two or three or even four or five years; it is a process which affects the whole generation and the generation is the time constant in which the educational process can be seen take the effect." (CABE, 1967).

Our's is a big country. If all the school-goers of the country were to get knowledge of science and its applications and acquire scientific temper, the problem would be solved. However, on the one hand, educational opportunity could not be provided to all and on the other hand, majority of our school goers drop-out without completing the primary and the middle school education.

For the country as a whole the gross enrolment ratio for the age-group, 6-10 years was 82.32 per cent and the gross enrolment ratio for the country for the age-group 11-13 years was 36.92 per cent on 30th September, 1978 (NCERT. Fourth Educational Survey, p. 6). It is clear from this that 30.38 per cent only (36.92 per cent of 82.31) aspired for higher education and 69.62 per cent children of the age-group 11 to 13 years were out of the school system. Since the 17.69 per cent of the children at primary level are out by the time they pass primary stage and 69.62 per cent children at middle level are already out by the time they pass middle class, therefore, a purposeful science education programme-suitable instructional materials is needed specially upto primary and middle level of schooling. Thus, primary and middle stages appear to be the most important areas.

Another important factor in the implementation of policy is the coordination amongst various Policy-making, Planning and Implementing agencies both at the central and state level. As the implementation of policy is the test of a successful policy, it ought to be seen how a policy framed at national level had some sort of convergence of ideas, priorities and perception of needs or was there some sort of divergence as reflected in its implementation.

Again a science education policy is further handicapped, by wide variations in school structure. This diversity may make the task of central planning and coordination still more difficult. A Five Year Programme of school science developed at national level would not necessarily be relevant for all the states especially when the span of primary school's duration varies from state to state and even within a state from region to region.

Statement of the Problem

Presuming on the basis of foregoing discussion that a study of school science education policy over a period of 30 years of post-independence would be of some value to the policy makers and planners, if it focusses on analysing the experiences gained during the period 1947-77, the present investigator took the following study.

"A CRITICAL STUDY OF THE DEVELOPMENT OF SCHOOL SCIENCE EDUCATION IN INDIA FROM 1947-77."

Delimitations of the Study

The researcher is fully conscious of the wide scope of the subject area and various constraints. Education itself is a sub-system and in this sub-system there are various dimensions such as a group of policy makers, planning strategists, academic set-up, administrative set-up, teachers, students, facilites etc. School education is multi-dimensional. It depends on a large number of factors which interact with each other. The effective factors are many and it may be difficult to prepare an exhaustive list. Moreover, these factors vary from one state to another, from one school to another, from one environment to another, in the same class from one pupil to another. The network of factors is indeed very complex. It makes school science education a very complex. enterprise.

However, to study evolution of school science education, curriculum seems important as it reflects, as pointed out by Secondary Education Commission, the totality of experiences, national objectives and various strategies to achieve them. It is the pivot of teaching-learning situations. Not only in our country but even in the Asian region, as pointed out in UNESCO Bulletin, "by far the most significant recent development in the developing countries of the region (Asian) has taken the form of establishing a separate institution for curriculum development in science. This institutionalization of curriculum development in science education has also led to the association of expertise from various bodies within and outside the educational system in developing new science curriculum." (Bulletin, 1977, p. ii). The UNESCO bulletin further observed that "all countries in Asia, without exception, have chosen curriculum as the focal point of their progrommes for the renovation of science education." (Ibid., p. ii). Thus curriculum appears the focal point for the renovation of science education. It is the pivot of school science education and is framed according to the policy. Thus, keeping in view the constraints, time, resources, the investigator delimited the study to review the efforts made at the national level for developing science curriculum policy for primary and middle school level (for classes I to VIII).

Plan of the Study

Having decided upon the title 'A Critical Study of the Development of School Science Education in India from 1947-77' to be investigated and having delimited the study to primary and middle classes (I-VIII), the first task was to discuss the matter with knowledgeable persons. Accordingly the information was collected from various sources, such as, (i) Reports of the vorious commissions, committees, Ministry of Education, NCERT, Five Year Plans, CABE's reports and Report of the Ministers and Secretaries conferences (ii) personal interviews (unstructured) with persons involved in various committeess for framing the policies, and science edcation workers (iii) visits to institutions connected with implementation of policies on science education, State Councils of Educational Research and Training (iv) filled-in questionnaires received, under SEP Projects by the Department of Education in Science and Mathematics, NCERT (Courtsey Prof. A.N. Bose, Head of the Department and Dr. B.D. Atreya, Coordinator, SEP Project No. 1 UNICEF assisted project).

However, inspite of best efforts of the present investigator, a number of background papers and documents could not be secured from a number of sources like Planning Commission, Ministry of Education, Department of Science and Technology and National Archives. The present investigator hopes that some other investigator later analysing the events of this period may get these in the National Archives as and when available and may perhaps reach conclusions based on a much more enlightened perspective. To analyse the kind of information available there was no study from which guidance could be taken. However, the present investigator decided to tabulate the available information vertically yearwise and horizontally the information available from different agencies, such as, Ministry of Education, Central Advisory Board of Education, Commissions and Committees Missions, Planning Commission (Plans), Institutions, Organisations, some important events and other available information in literature. The tabulated information gave a totality of work done in the area, and helped in analysing critically the documents.

REFERENCES

Mahalanobis, P. C. 1962. The Scientific Base of Economic Development in (*NCERT, 1962*).

Mishra, A. K. 1983. 'Environmental Studies: Approach and Scope' in (*Shukla, R. D. (Ed.), 198?. Science and Mathematics Education – A New Perspective, New Delhi: NCERT*).

NCERT, 1962, *Position of Science Teaching in Indian Schools A Factual Report*. New Delhi: NCERT.

NCERT. 1980, *Fourth All India Educational Survey*, 1978. New Delhi: NCERT.

Sarabhai, V. 1967, in (*The Proceedings of the Meetings of the Central Advisory Board of Education*, (CABE). April, 28 to April 30, 1967. New Delhi: Ministry of Education.

Singh Raja Roy 1963. *Emergency Problems in Indian Education*. Delhi: Central Institute of Education.

UNESCO. 1977, *Bulletin of the UNESCO Regional Office for Education in Asia. Science Education in the Asian Region*. Bangkok: UNESCO Regional Office for Education in Asia.

Crane, R. I. 'Technical Education and Economic Development' in (Anderson, A. C. and Bowman, M. J. (Ed). 1966. *Education and Economic Development*, Chicago: Aldine Publishing Company.

Gupta, S. C. 1979, *Modern India and Process in Science and Technology*. New Delhi: Vikas.

Rahman, A (et. al). 1973, *Science and Technology in India*. New Delhi: Indian Council for Cultural Relation.

Rahman, A. and Sharma K. D. (Ed). 1974, Scientific Policy Resolution, *Science Policy Studies*. New Delhi: Somania Pub. Pvt. Limited.

Rahman, A and Sharma, K. D. (Ed.), 1974, Scientific, Policy Resolution. *Science Policy Studies*. New Delhi: Somania Pub. Pvt. Ltd.

Shenoy, Sudha R. 1971. *Central Planning in India—A Critical Review*. New Delhi: Wiley Eastern Private Limited.

Singh R. P. 1972, *Notes on Writing of History of Indian Fducation*. Belgium: Historica Pedgogika.

UNESCO. 1971, Science for Development. A I ssay in the Origin and Organisation of National Science Policies.

UNESCO. 1972, Science Policy Studies and Documents, No. 27. National Science Policy and Organisation of Scientific Research in India. Paris: UNESCO.

Zaheer, S. H. and Rahman, A. 1963. 'Science and Social Change'. *Science in Parliament*, 1963. (Vol. I, No. 4).

Anderson Janathan (et. al). 1970. *Thesis and Assignment Writing. New Delhi: Wiley Eastern Private Limited.*

4

SCHOOL SCIENCE EDUCATION DURING BRITISH PERIOD

> Perhaps, no acquisition in natural philosophy would so effectively enlighten the mass of people, as the introduction of the principles of mechanics and their application to agriculture and useful arts. Not that the Hindus are wholly destitute of simple mechanical contrivances; but perhaps for two thousand years they do not appear to have made any considerable additions to the art of life. Few things they have improved by their intercourse with Europeans, of whose immense superiority they are at length convinced; but this effect is partial, and not discernible in the bulk of the people. The scope for improvement, in this respect, is prodigious. (Grant's Observations, Sharp, H. (Ed.), p. 85)

In India, modern science was introduced by the European naturalists, medicalmen, engineers and other technical men who came with commercial and trading enterprises. Towards the close of fifteenth century the early European traders were the Portuguese, who occupied Goa (1510) and built up a dominion on the western coast. Garcie-da orte, the portuguese physician and botanist came to Goa in 1534 and spent thirtysix years in western India studying scientifically the flora of the region and established a botanical garden in Goa wherein he nursed a number of medicinal plants. A number of Jesuit missionaries brought with them the then prevalent knowledge of Astronomy, Geography, Natural History. (Subbrayappa, 1971. p. 490) Whereas in Europe, the traditional and authoritarian views which held the ground for centuries were subjected to searching rational analysis during the sixteenth and seventeenth centuries as a result of which the old theories began to yield place to new, in India, traditional learning by and large held sway. Though these enlightned traders and missionaries were active in the social and political field, to what extent their knowledge of modern science was able to influence the local Pandits, Maulvis and rulers can not be envisoned with certainty. But it must have had some effect, may be just at an information level.

India, as we know, was invaded by various foreign powers from time immemorial. But no foreign power could bring about any substantial transformation in the basic socio-economic structure or the cultural milue of this sub-continent. The reason may be, as Chowdhury held, "the technological and cultural superiority of India as compared the nomadic invading forces . . . in gradual process invading forces were indianized in course of time." (Chowdhury, 1980. p. 54) However, this did not happen in case of Europeans, particularly, the British who finally established their colony in India. After the battle of Plassy (1757) the Britishers by and large established their supermacy and heralding the industrial revolution backhome, with a superior knowhow in state administration as well as military strategy, made a marked impact upon the socio-economic structure and cultural milue of India.

The East India Company for long was concerned mainly with its commercial interests and hence chose to be indifferent towards the promotion of education of the people in India. As the Muslim rulers were replaced by the British, some efforts to promote western education were made. Warren Hastings, providing a building at his own expense, founded a Madarasha at Calcutta (1781) to qualify the sons of Muhammadan gentlemen for responsible and lucrative offices in the State. (Sharp, p. 7) The Madarasha was intended for the encouragement of the study of Arabic and Persian and of the Muhammadan law with a view to provide officers for the courts of justice. The courses included Natural Philosophy, Theology, Law, Astronomy, Geometry, Arithmetic, Logic, Rhetoric, Oratory and Grammer. (Sharp, p. 30) Jonathan Ducan, the resident at Benaras too founded the Benaras Sanskrit College which was maintained by Government, for the preservation and cultivation of the laws, literature and religion of Hindoos. The courses included Theology, Traditional Medicine, Music, Mechanical Arts, Grammer, Prosody, Sacred Lexicography, Mathematics, Metaphysics Logic, Law, History, Ethics, Philosophy and Poetry. (Sharp, p. 31).

Thus, though the East India Company did not initially assume formal responsibility for the education of Indians, its individual officers here and there used public funds for the founding and maintenance of institutions of oriental learning. It is during this period again that foundation of scientific investigations in India too was laid. For instance, Sir W. Johns and some European intellectuals founded 'The Asiatick Society' which did considerable work in the field of science. Henry Trail, as early as 1784, made meteorogical studies, maintained meteorogical diary at Calcutta using the barometer, hygrometer, wind direction and rainfall during the period (1785-1788). In 1789 William Hunter recorded observations on the rainfall, and initiated climatic studies too. The Royal Botanic Garden (now Indian Botanic Garden) came into existence in 1787 at Sibpur on the west bank of the river Hooghly. Similarly, the Madras observatory was established in 1792 for promoting the knowledge of astronomy, geography and navigation in India. (Bose, D.M. et. al., (Ed.) p. 494).

However, in spite of an awareness of the need to educate Indians and some efforts at scientific investigations, educational centres run by Europeans were restricted to traditional learning and narrow scholasticism. As pointed out by Subbarayappa:

> Education in India in the early part of the nineteenth century was neither widespread nor designed towards the promotion of science as well as technical arts and crafts. A few centres of learning then functioning in Bengal, Bombay and Madras

were largely concerned with traditional learnning and narrow scholasticism. (Ibid., p. 541)

School Science Education under East India Company

By the end of eighteenth century efforts were mounted to actively involve the otherwise neutral and sometimes hostile East India Company in the task of 'educating' the ignorant' masses of our country. In the 1792, Charles Grant, an ex-employee of the Company wrote his famous 'observations' in which he advocated that "regeneration of India should be undertaken by Great Britain by spreading Christianity for religious and moral upliftment of masses, and through education in English language and and literature, and of western mechanical sciences including 'the skilful application of fire, of water, and of steam". (Sharp, p. 85)

In 1792-93, when the Charter of the Company came up for renewal, Grant succeeded in pursuing Wilberforce to move the following resolution in the House of Commons:

> That it is the peculiar and bounden duty of the British Legislature to promote by all just and prudent means the interests and happiness of the inhabitants of the British Dominions in India, and that for these ends such measures ought to be adopted as may gradually tend to their advancement in useful knowledge and to their religious and moral improvement. (Sharp, p. 17).

He proposed to introduce into the bill specific measures for the encouragement of missionaries and school masters to be sent out from England. But the opposite party in the court of Directors urged that the Hindus had as good a system of faith and of morals as most people and that it would be madness to attempt their conversion or to give them any more learning or any other description of learning than what they already possessed. (Sharp, p. 17) So due to strong resistance and lobbing by the Directors of East India Company especially against 'religious and moral improvement' of Indians, the resolution could not be passed. However, enlightened liberal minded company as well as Indian educated in western knowledge went on mounting pressures for making East India Company assume responsibility for education of Indians. For example, Lord Minto wrote on the subject of education in India (1811) highlighting the decay of learning. (Sharp, p. 19) So, when the Charter of East India Company came up for renewal, a clause No. 43 was inserted in the East India Company Act of 1813 which directed that:

> . . . a sum of not less than one lac of rupees in each year shall be set apart and applied to the founding and maintaining of colleges, schools, public libraries and other institutions for the revival and improvement of literature, and encouragement of the learned natives of India, and for the introduction and promotion of a knowledge of the science among the inhabitants of the British territories in India. (Sharp, p. 22)

In a way, this clause laid the foundation stone of English educational system in India with the purpose of 'revival and improvement of literature and encouragement of learned natives' on the one hand, and 'promotion of the knowledge of sciences' on the other. The 'promotion of the knowledge of sciences would have helped in laying down the foundation of science education in India, but the opportunity was lost in the wake of controvercies between the 'orientalist' who advocated education through the medium of oriental classics on old established rules, and the 'anglicists' who advocated through the medium of English and the vernaculars in accordance with modern ideas. (Bhargava, K. D. (Ed.), 1968. Selections from Educational Records, Part IV, p. 10).

The controversy arose as to how the grant of one lakh rupees was to be utilized. The 'Orientalists' and some of missionaries, perhaps, in order to secure goodwill of masses, advocated the use of funds for oriental learning in classical languages. Some of the eminent educationists like Rev. C. Thomson, Mountstuart Elphinstone and the Rev. D. Bryce advocated the improvement of village vernacular schools as the only way to educate India. They suggested that by giving higher pay to teachers, by preparing suitable textbooks and by subjecting teachers to certificate examinations in teaching, the standard of these village schools and through them of the whole country would be raised.

On the other hand the Anglicists too mounted their efforts to have English medium schools—restricting education to English literature and science. In the Presidency of Bombay, Bombay Education Society and Bombay Native Society established schools in Bombay, Surat, Thana and Broach. The American Marethi Mission opened also a primary school for boys in 1815—the first school conducted on western lines in the Presidency. (Bose, D. M. et. al., (Ed.), p. 543)

Similarly, Raja Ram Mohan Roy started a school (1816) at Suripara in Calcutta. He along with Sir Edward Hyde East, David Hare, Raja of Burdwan, Raja Radha Kanta Deo and others founded a 'Seminary' (similar in character to those which existed in Europe before the time of Lord Bacon) for the instructions in the European and Asiatic languages and sciences. It was called Mahavidyalaya (Mahapathsala) which later became Hindu College, and still later Presidency College. The subjects taught included Arithmetic, Astonomy, Chemistry and Natural Philosophy. It had two sections—a school which imparted instructions in English, Bengali, Grammer and Arithmetic, and a College in which were taught besides the Language and History, the sciences including Asronomy, Mathematics and Chemistry, Natural and Experimental Philosophy, Algebra. This institution worked so well that the visitor of this institution H. H. Wilson in 1831 wrote that ". . . a command of English language and a familiarity with its literature and science had been acquired by the institution to an excellence rarely equalled by any school in Europe". (Bose, D. M. et. al., (Ed.). p. 544) Rev. Dr. Middleton, the first Bishop of Calcutta also opened a missionary college (now called the Bishop's College) in 1818, to impart western knowledge. (Sharp, p. 79) Thus there emerged two types of education—one imparted in the indigenous pathsalas and tols in places like the Calcutta Madrasha and the Sanskrit College at Benaras, and the other that was imparted in schools managed by missions and societies and in institutions, which contained the germs of the later English High School and Arts College.

However, till the year 1823, the grant of one lakh rupees was not appropriated for its proper purposes and the Governor General appointed a General Committee of Public Instruction "for the purpose of ascertaining the state of public education and of the public institutions designed for its promotion . . . and from time to time submitting to Government the suggestion of such measures, as it map appear expedient to adopt with a view to the better instruction of the people, to the introduction among them of useful knowledge and to the improvement of their moral character." (Sharp, p. 53) The General Committee of Public Instruction, consisting of ten members including H. H. Wilson a noted Sanskrit scholar as its Secretary was equally divided as to what 'useful learning' meant. While the Government instructed the committee for the completion of the arrangements for the construction of the proposed Hindu College of Calcutta and the new Madarasha and directed to introduce European Science as far as practicable in the studies and disciplines of the institutions, the 'orientalists' in the committee clung to the old pattern of traditional oriental learning (Sharp, p. 56). The establishment of Sanskrit College at Calcutta, though founded with an object of seeking by 'every practical means of diffusing European knowledge', was therefore not well received by enlightened Indians themselves. Raja Ram Mohan Roy made a vigorous protest (1823) to Lord Amherst and among other things he pleaded:

> . . . the improvement of the native population is the object of the Government, it will consequently promote a more liberal and enlightened system of instruction, embracing mathematics, natural philosopy, chemistry and anatomy, with other useful sciences which may be accomplished with the sum proposed by employing a few gentlemen of talents and learning educated in Europe and providing a college furnished with the necessary books, instruments and other apparatus. (Sharp, p. 101).

The court of Directors, too, in the despatch of 1824, regarding the measures adopted for the reform of the Hindu College at

Benaras and Mohammadan College at Calcutta, observed that these measures were originally and fundamentally erroneous. They directed that "the aim should not be to teach Hindu Learning or Muslim learning but useful Learning." (cited by, Vakil and Natrajan, p. 103)

In Madras, a Public Committee of Instruction was constituted in 1826 at the direction of Sir Thomas Munro who looked after the establishments in Madras presidency. The efforts were appreciated and the Court of Directors, in the Despatch of 1830, wished that "there should be an English teacher at each institution who should not only give instruction in the English language but who may likewise be capable of assisting the students in study of European Science." (Bose, D. M. et. al., (Ed.). p, 541) Thus, though the Court of Directors as well as liberal public opinion favoured in European languages and science learning the General Committee of Public Instruction went on debating in favour of oriental learning. Finally in 1835 the Secretary of Committee submitted the matter to the Governor General in Council for 'some decisive general instructions from Government'.

However, by this time the expansion of English education as well as the needs of Government had already titled the debate in favour of European languages and Science. For example, the Charter Act of 1833 had laid down:

> And it is our further will that, so far as may be, our subjects, of whatever race or creed, be freely and impartially admitted to offices in our service, the duties of which they may be qualified by their education, ability and integrity, duly to discharge. (Cited by Vakil and Natrajan, p. 117)

Similarly when Elphinston College was established (1834) with the approval of Government, the Government hoped that the college would be instrumental in raising a class of persons qualified by their intelligence and morality for high employment in the civil administration of India. Obviously, when interpretation of clause 43 of East India Company Act 1813, was referred to Macaulay, he had little difficulty in clinching the debate between Orientalists and Anglicists in favour of western learning through English language. Macaulay, in his minute, observed:

> It is argued, or rather taken for granted, that by literature the Parliament can have meant only Arabic and Sanskrit literature; that they never would have given the honourable appellation of a 'learned native' to a native who was familiar with the poetry of Milton, the metaphysics of Locke, and the physics of Newton, but that they meant to designate by that name only such persons as might have studied in the sacred books of the Hindoos all the uses of cusa-grass, and all the mysteries of absorption into the diety. (Sharp, p. 116)

After going into the various facet of the debate Macaulay opined "that we are not fettered by the Act of Parliament of 1813, . . . that we are free to employ our funds as we choose, that we ought to employ them in teaching what is possible to make natives of this country thoroughly good English scholars, and to this end our efforts ought to be directed." (Sharp, p. 116) He made a suggestion an often quoted one, and sometimes misconstrued, to achieve this end:

> It is impossible for us, with our limited means, to attempt to educate the body of the people. We must at present do our best to form a class who may be interpreters between us and the millions whom we govern—a class of persons Indian in blood and colour, but English in tastes, in opinions, in morals and in intellect. To that class we may leave it to refine the vernacular dialects with terms of science borrowed from the western nomenclature, and to render them by degrees fit vehicles for conveying knowledge to the great mass of the population. (Sharp, p. 116)

Lord William Bentinck concurred entirely with the arguments advanced by Macaulay and after thorough consideration of the note by H. T. Prisep and letters from the Secretary to the Committee of Public Instruction, the following Resolution was issued:

> His Lordship in Council is of the opinion that the great object of the British Government ought to be the promotion of European literature and science among the native of India; and that all the funds appropriated for the purpose of education would be best employed on English education alone. (Sharp, p. 130).

Lord William Bentinck's decision gave a turn to Indian education towards European literature and science, encouraging the education of a few through English, and leaving the education of many through their mothertongue to their own resources. The English education got a push and the Anglicists position got strengthened. By 1838, there were some six thousand pupils taking up new courses in western literature and science. (Bose, D. M. et. al., (Ed.) p. 546)

In 1939, Lord Auckland tried to pacify the Orientalists by guaranteeing the continuation of the existing institutions of oriental learning, payment of salaries to the eminent professors, adequate scholarships to students, publication of useful books in oriental languages, and permission to impart instruction in oriental learning, provided they also conducted English classes. On the other hand, he took steps to the spread of education in English literature and Science in order to satisfy the Anglicists by directing that:

> The principal aim of educational policy should be able to communicate, through the English language, a complete education in European literature, philosophy and science to to the greatest number of students who may be found ready to accept it. (Sharp, p. 147)

Thus education in European literature, philosophy and science in the English schools received another boost and downward filtration theory became the official policy in education. This type of education given in English schools also became a requisite for entrace into government services and the subsequent proclamation, issued by Lord Hardinge in 1844 that preference was to be given for service in public offices to those who were educated in English schools, popularised it further.

The science and technological developments upto 1854, the year of the famous Educational Despatch were various and many. In 1814, Nathaniel Wallich came as the superintendent of the Botanic Garden whose botanic collections were sent to the European Centres of botanic studies. In 1815, the Lambton prepared a general map of southern region. In 1818, Great Trigonometrical Survey was made at Calcutta, and in 1822, an Atlas of India was prepared in the quarter inch scale. In 1830, George Everest came as the Superintendent of the Great Trignometrical Survey. In 1832, the Journal of the Asiatic Society of Bengal came out. In 1835, Calcutta Medical College was established and a medical school at Madras was established in 1843. In 1845, the Grant Medical School at Bombay was established. In 1847, an Engineering Institution at Roorke was established. In 1851, Geological Survey was founded mainly due to the efforts of Thomas Oldhams. In the same year the first telegraph line for a distance of fifteen miles between Alipore and Rajghat near Calutta was laid down as also the first railway line covering a distance of twenty miles between Bombay and Thana in 1853. All these required 'natives' to shoulder some responsibilities for scientific and technological enterprises.

So when the Company's Charter came for revision, the Board of Directors took note of the prevalent situations and issued the Educational Despatch of 1854 (popularly known as Wood's Despatch) which according to Lord Dalhousi contained, "a scheme of Education for all India, for wider and more comprehensive than the local or the Supreme Government could ever have ventured to suggest." (Richey, J.A. (Ed.). 1922, p. 364) Indeed the Despatch of 1854 has been considered as a major landmark in the development of Indian School System. By proclaiming that "it was one of the most sacred duties, to be the means, of confering upon the natives of India those vast moral and material blessings which flow from the general diffusion of useful knowledge (Ibid., p. 364) the Despatch imposed the responsibility for the education of masses, repudiating the 'downward filtration' theory "at least on paper." (Chandra, Modern India. p. 181)

The Despatch emphasized that the Directors, "always looked upon the encouragement of education as peculiarly important," as it supplied to them servants 'whose probity' 'offices of trust' could be committed with increased confidence. (Richey, p. 365)

The Despatch further advocated that:

> The advance of European knowledge in India will not only teach the natives of India, the marvellous results of the employment of labour and capital rouse them to emulate us in the development of vast resources of their country . . . but also secure for England a large and more certain supply of many articles, necessary for her manufactures and extensively consumed by her population, as well as an almost inexhaustible demand for the produce of British labour. (Richey, p. 365)

The Despatch directed to create 'Educational departments' as a portion of the Government machinery to be responsible for educational efforts. As the Directors were concerned how useful and practical knowledge could be best conveyed to the 'great mass of people', who in Director's view, were 'utterly incapable of obtaining any education worthy of the name by their own unaided efforts'. They desired to see, the active measures of Government more especially directed, for the future, to this object, for the attainment of which they were ready to sanction a considerable increase of expenditure. The Directors conceived of schools whose object was not to provide high training to few youths, but to provide more opportunities for the acquisition of such an improved education as would make those who possessed it to become more useful members of society in every condition of life. (Richey, p. 376) They included the anglo vernacular and vernacular schools in the same class because they were unwilling to maintain the broad line of separation which at that time existed between schools in which the media for imparting instruction differed. The knowledge conveyed at that time was much higher in anglo vernacular than in the vernacular schools. Directors desired to minimise the difference. They observed:

> Difference will become less marked, and the latter more efficient, as the gradual enrichment of the vernacular languages in works of education allows their schemes of study to be enlarged, and as a more numerous class of school masters is raised up, able impart superior education. (Richey, p. 377)

Thus by suggesting action to create a separate department of the Administration for the work of Education; the institution of universities at the several Presidency towns, establishment of training institutions for raising up teachers for the various classes of schools; the maintenance of the existing government colleges and schools of high order, and the increase of their number when necessary, the establishment of additional zila or middle schools, increased attention to vernacular schools for elementary education, including the indigenous schools already existing throughout the country, and finally, the introduction of a system of grants in aid, under which the efforts of private individuals and of local communities would be stimulated and encouraged by pecuniary grants from government, in consideration of a good secular education afforded in the aided schools and by expressing its intent to provide useful and practical knowledge suited to every station of life to the all class of people i. e., "general education and as a part of it science education," (Bose D. M. et. al., (Ed.), p. 547) . . . the Educational Despatch of 1854 would indeed have been the Magna Charta of English Education in India, had it not been for other socio-political factors. The anglo-vernacular schools, mainly catering to the prosperous classes, maintained their emphasis on literary subjects with the limited object of cultivating native talent for absorption into the British political-administrative structure, and no attention was paid to the study or application of science at school stage. Some engineering and Allied Technical Education Institutes came up to produce subordinate officers of public works department and to meet the immediate requirement arising out of the need to create an infrastructure for trade i. e., transport and communications, and not because of any considered policy of science education, industrial development or technical education. Again, placing of the universities for the benefit of education of the higher classes contributed more to an intensive study of the liberal disciplines at the cost of study of sciences and their applications. No wonder then, because the needs of university education determined the school curricula more than need to provide for 'useful and practical knowledge' suited for every station of life', school syllabi were framed as preparatory to University education even though only a few entered the universities. Thus it may be seen that inspite of all this there was a little development in the area of school science education.

School Science Education during the period 1859-1900

After 1857, and by the end of 1859 Imperial authority over India was established. The policies laid down by Despatch of 1854 were by and large reaffirmed by Secretary of State in his Despatch of 1859. The pattern of educational system envisaged in these Despatches began to take shape. At that time, schools were known as village schools, Tahseelee Schools, Talook or Town schools. The course of study comprised reading, writing, grammer, composition, arithmetic, mansuration, algebra upto quadratics, the first four books of Euclid, History and Geography of India, General Geography, Ancient History, the elements of political economy and plantable surveying. (National Archives of India. 1960. Selections from educational records (1859-71) Volume I. p. 53). By and large the emphasis was on liberal studies and on English. It was recommended that "in upper classes English should preponderate over the vernacular, and be the medium for imparting instruction in Science." (Ibid., p. 276) Obviously only those persons could obtain instruction in science who had learnt English. So by imparting instructions in science through English mass of children who went to vernacular schools could not receive the benefit of science education.

The emphasis on 3 R's and liberal studies has been attributed to a kind of carry over of the pattern of school instruction in

Britain. Introduction of science in schools in Britain received impetus after the great exhibition of 1851. Insistent demands were made for its inclusion in the curriculum of schools. This resulted in the establishment of a Department of Science and Arts, in 1853, by the British Government for the encouragement of these subjects. About this time John Tyndall pleaded for physics as a branch of study in school; Faraday stressed the importance of cultivating of scientific outlook; Herbert Spencer advocated the importance of science in general education, and T. H. Huxley pleaded for the inclusion of science in every scheme of secondary education. The Public School Commission set up to inquire into the administration of the nine great public school of Britain (1861-1864) found that "while ample facilities were provided in these schools for the study of Latin and Greek, natural science was practically excluded from curriculum". (All India Council for Secondary Education, 1956. p. 18). The Commission described this as 'a plain defect and a great practical evil', and urged the teaching of Natural Science—two main branches, one comprising Physics and Chemistry, and the other comprising Physiology and Natural Histosy. The Elementary Education Act of 1870 heralded the science schools and day technical schools assisted by grants from science and art departments. Science was introduced in public examinations and grants to schools began to be given for the teaching of science. However, such developments in the school curriculum in Great Britain had little impact upon the courses of studies in Indian schools. Even though, the establishment of universities at Calcutta, Bombay and Madras, and Engineering School at Poona (1854), Engineering College at Sibpur (Calcutta), Civil Engineering College at Madras (1859), Archeological Survey of India (1859), Indian Museum (1867) at Calcutta, Indian Meteorological Department (1875) and Indian Association for the Cultivation of Science led to scientific activities undertaken by a number of individuals both European and Indian, but this did not make such impact upon the curriculum of vernacular schools as far as the introduction of science as part of it was concerned.

The Indian Education Commission (1882-83)

In the beginning of eightees, the Government of India, as pointed out by Bhargava (1968), realized that "a purely literary education had not produced a supply of candidates for employment in excess of the demand." (Selections from Educational Records (1886-1907) p. 1). Earlier by the end of seventees the number of purely literary scholars unable to find employment grew up continually increased and when mining, manufacturing and other large industries began to develop, it was felt that "education in India should be adapted to suit the changed conditions." (Ibid., p. 1) The need of industrial occupation for a larger portion of the people came into prominence with the rapid increase in the agricultural population too. These were circumstances in which the Indian Education Commission (1882-83), popularly known as Hunter Commission, was appointed by the Government of India with a view to enquire into the working of the existing system of Public Instruction and to the further extension of that system on a popular basis and to enquire particularly into manner in which effect had been given to the Despatch of 1854 and to suggest such methods as it might think desirable with a view to more completely carry out the policy therein laid down. The Commission was also made aware of the general importance which the Government attached to Primary Education and accordingly it was asked to enquire the existing state of elementry education throughout the empire, and the means by which this could be everywhere extended. (Indian Education Commission, p. 2)

The commission gave considered attention to primary education. The primary schools consisted of two divisions (1) the lower division containing pupil preparing for the lower primary school examination and (2) the upper division containing of pupils, who had passed this standard, preparing for upper primary school examination. For the lower primary school examination candidates were required to read at sight with facility a moderately easy book in a vernacular language, to write to dictation from the same and to work sums simple and compound in the first four rules of arithemetic. For the upper primary school examination candidates were required (1) to read at sight with fluency and intelligently a passage of ordinary difficulty from a book or newspaper in a vernacular language, or in the case of Europeans and Eurasians in the English language (2) to write a passage to dictation from the same, (3) to work miscellaneous questions in arithmetic—the precise standard to be determined by the local Government and (4) to pass an examination in at least one additional subject to be determined by the Local Government. (Ibid., p. 119). Though the Government of India desired uniform standard of examination for primary schools and laid down general regulations (6th January 1879), the position of course content was different in different places. Connigham's Sanitary Primer was presented for primary schools.

The Commission pointed out that parimay education be regarded as the instruction of the masses through the vernacular in such subjects as would best fit them for their position in life and be not necessarily regarded as a portion of instruction leading upto the University. (Ibid., p. 81) The Commisson recommended:

> That the standards of primary education in each Province be raised with a view to simplification and to the larger introduction of practical subjects such as native methods of arithmetic, accounts and mensuration, the elements of natural and physical science and their application to agriculture, health and the industrial arts. But that no attempt be made to secure, uniformity through out India (Ibid., p. 127).

This recommendation was in tune with the observations of the Royal Commission (1881-84) on Technical Education that for the great mass of our working population who must necessarily begin to earn their livelihood at an early stage, it is essential that intruction in the rudiments of the sciences bearing upon industry should form a part of the curriculum of elementary schools." (Bhargava, (Ed.). 1968, Selections from Educational Records, Vol. IV. p. 73) Later, in July 1886, the Home

Secretary, while examining the condition of education in general and technical education in particular observed the neglect of 'useful and practical knowledge to the great mass of the people' and suggested that "the teaching of rudimentary principles of science as soon as some progress had been made with the 3 Rs." (Ibid., p. 2) which according to the prevalent pattern of elementary education meant that teaching of science was to start after the first three years of lower primary classes when the pupils entered the upper primary classes.

In spite of the recommendations of the Indian Education Commission, Royal Commission, and Home Secratary's observations, the introduction of science in primary schools did not make much of a progress. Perhaps this was so because the Indian Education Commission on the one hand, recommended the introduction of elements of natural and physical sciences and their applications to agriculture, health and the industrial arts, but on the other hand, its recommendations regarding 'simplication' and 'not to attempt to secure uniformity throughout India' gave sufficient grounds to the educational administrators, who believed in laissez faire, not to make any serious efforts to introduce sciences in primary schools curriculum.

While reviewing the state of education in India with special reference to recommendations of Indian Education Commission (1882-83), Croft (1888) found that the introduction of the science subjects met with active criticisms, on the ground that 'the particular subjects recommended did not seem to tend towards 'simplification of the course'. (Review of Education in India in 1886, p. 232) For example, the Government of Madras around that "In a country where so little education of any short has been till recently available for masses, to ask a child under primary instruction to master the elements of science and their application to agriculture and the arts, is to ask too much." How much was needed? The Government of Madras directed that "a child during the four years of his primary course, ought to confine his attention to reading, writing and arithemetic, with possibility the elements of history and geography". (Ibid., p. 232) Similarly, in the Central Provinces according to Croft:

> 'Simplification' was understood to mean reduction; sanitary primer was introduced but it was doubtful whether anything to which the name 'Science' or 'Agriculture' was aplicable could be usefully taught in primary schools. These subjects—elements of natural and physical science and their application to agriculture and arts into the primary course were beyond the capacities both of teachers and of boys. . . . Sanitary Primer was found to be a severe tax on the understanding of children . . . In Bengal, the Sanitary primary was condemned as too difficult for the lower primary course. . . (Ibid, p. 233).

Lord Ripon, the then Viceroy, in order to provide 'a measure of political and popular education' set up District Boards and Municipal Boards at least half of whose members were popularly elected. The subjects entrusted to them included education, health, sanitation and public works, and they were given limited powers to levey taxes. The fact that elementary education was remitted to these inexperienced bodies was according to Sargent (1968), an indication of how little those in authority were concerned with this problem. (Society Schools and Progress in India, p. 10) Not much could not therefore be achieved as far as reform of primary school curriculum was concerned. The Government of India in its resolution of 1897 had to direct that "elementary science should be compulsorily taught through the readers and object lessons in a primary school." (Bhargava, (Ed.), 1968, Educational Records (1886-1907) part IV, p. 137) The object lessons were to be arranged with special refence to the locality in which the shchool was situated.

Science Courses for Middle School Stage

As far as the education of the middle school stage was concerned, it appears that the Indian Education Commission could not give it any special consideration. Even though the Government o India directed the Commission that:

> The great majority of these who prosecute their studies beyond the primary stage will never go beyond the curriculum of the middle or at furthest of the high schools. It is, therefore of the utmost importance that the education they receive should be as thorough and sound as possible. (Indian Education Commission, p. 4).

The Commission appears to have subsumed the middle schools within the ambit of primary education in case of Bombay and Madras, and within the ambit of secondary education in northern India mainly due to the way these middle schools were administered in these parts. To obiate the confusion resulting from the nomenclature, the Commission recommended that high schools and middle schools were to be united in the returns under the single term 'secondary schools'.

Be that as it may, recommendations regarding introduction of science in primary schools cited earlier may be presumed to be applicable to the curriculum of middle schools as well. However, the courses of studies in middle schools varied not only from province to province but also within the each province. For example, in Bengal, these variations were largely due to the perceptions regarding the requirements of pupils where education was to terminate at the middle stage as being different from those who were expected to proceed further to high schools and subsequently to universities. (Indian Education Commission, p. 178) These middle schools, presumed to be terminal in character, were called 'Independent Middle Schools'. (Ibid., p. 213) The middle schools articulated with high school examination or University Entrance Examination were governed by University standard and the courses of study were determined accordingly. The students in the middle schools received instructions in English, the vernacular, arithmetic, geography and history as the core liberal subjects of study al throughout British India. As far as the sciences were concerned the Cunniggham's Sanitary Primer was prescribed in Bombay and North Western Provinces and Oudh. It was only in case of Bengal that apart from the liberal subjects within the ambit of high school, the 'Independent

Middle Schools' had additional subjects—preservation of health and the sanitary Primer in addition to one of the following: elements of Natural Philosophy, elements of Botany and elements of Chemistry. (Ibid., p. 213)

Thus the teaching of science at middle school stage too had a more or less similar status in the curriculum as that as observed by Sir Alfred Croft in case of primary schools except in case of independent middle schools.

Science Courses for High School Stage

The Indian Education Commission (1882-83) will always find a place in the educational histosy of India for its recommendations regarding high schools. The high school curriculum was by and large literary in character which helped in producing scholars well versed in liberal disciplines capable of undertaking only governmental jobs, the demands for which had slowly narrowed down. Except in Bombay where the children coming from agricultural background received instructions in practical agriculture together with science courses as well as incentive scholarships to take up such courses, nothing was done elsewhere to provide 'useful and practical knowledge suited for every station of life', though elements of Chemistry, Physics, Physical Geography were supported to be part of the school curriculum. In Bombay a wide range of general knowledge was expected of a candidate. It appears that the science subjects were taught orally, just as general knowledge. Even the Indian Education Commission itself observed that the "Course at Calcutta had nothing of experimental science differing in this part from other two Universities." (Report, p. 219) The Vice Chancellor of Bombay University, commenting on the teaching of science course, observed that "In physics and natural science, the difficulty is simply lamentable, and general information means general ignorance." (Ibid., p. 219)

The Indian Education Commission, amongst many other questions examined the question, Is the attention of the teachers and pupils in secondary schools unduly directed to the Entrance examination of the University." The replies to this question were singularly unanimous. It was felt in all provinces, and urged by many witnesses that the attention of students was too exclusively directed to university studies, and that no opportunity was offered for the development of what corresponded to the modern side of schools in Europe. The Indian Education Commission therefore perceived the real need in India for some corresponding course to make boys fit for industrial or commercial pursuits, at the age when they commonly passed matriculate examination more directly than was affected by the then existing system. (Ibid., p. 220)

Accordingly, the Indian Education Commission, thinking that in all provinces the institution of the alternative standard would provide real opportunities recommended that "in upper classes of high schools there should be two divisions, one leading to the entrance examination of the universities, the other of a more practical character, intended to fit youths for commercial or non-literacy pursuits. (Ibid., p. 221)

Efforts were made to implement the recommendations of the Indian Education Commission but to what extent they succeeded is matter of enquiry. In this connection the observations made by Mazumdar (1915) are worth mentioning. He observed:

> All these recommendations were of course generously accepted on principle; but only such effect could be given to them in practice as was possible under the eternal cry of financial difficulties. . . The official reports almost invariably winded up with the euphemistic platitude that "the recommendations of the Commission received the fullest attention compatible with the necessity of avoiding any considerable increase of expenditure. (The Educational Problem. p. 353)

Concurrently the Government of India reviewed the state and progress of general education throughout India and its Resolution of 1888 dealt with the question of technical education. According to it technical education consisted of—

1. Technical education of a preliminary character including the study of natural science and the cultivation of the faculty of observating and reasoning from experiment and
2. Technical education proper is the preparation of a man to take part in producing effectively some special article of commercial demand. (Bhargava, (Ed.), 1968. Selections from Educalional Records, part. IV p. 3)

This resolution further enhanced the importance of science teaching at school stage because it was preparatory for further technical education or practical courses. The demand for such education by individuals as well as by groups together with the recommendations of the Indian Education Commission (1882-83), Government Resolutions and the growth of the so called 'economic nationalism' one would naturally expect a suitable status for science in the curriculum at school stage. But it did not happen except in a few 'independent middle schools' in Bengal or in Agriculture Schools in Bombay. One of the reasons may be that science educaiion at school stage was inextricably bound up with industrialisation of India, which the Britishers did not want simply because Britain needed a vast market—a colony, to be exploited for the surplus goods that its industrial revolution produced, and not a competitor. And so, as recorded by the Indian Industrial Commission (1916-18), "Throughout the nineteenth century, the policy of Government was controlled by the doctrine of 'laissez faire' (Report, par. 135). However, there were achievements in thearea of science and technology but they were not in accordancewith any planned policy. Subbrayappa (1971) has coroborated this in these words:

> As a result of the military and commercial motives on the one hand and adminstrative exigencies which cropped up from time to time on the other, the government had to adopt concerted measures for making the then existing scientific service organisations more broad based and utilitarian. (Bose. D. M. (Ed.). p. 499)

Be that as it may, during the period 1859-1900, school science received the attetion of the government. But only those students could learn modern science who studied English language, as English language was declared the medium of of imparting instructions in science. Inspite of the Indian Education Commission's recommendations for the introduction of science in school curriculum right from primary classes, Governments' resolution of 1888 declaring it as preparatory to technical or practical courses and Government Resolution of 1897, making compulsory the teaching of elementary science, there was little improvement in school science. No doubt, there was an awareness of the urgent need to introduce and promote modern science at school stage, even one may find half hearted efforts to implement the recommendations of the various despatches, commission, resolutions and reports regarding the school science education of the masses.

School Science Education during the Period 1900-1920

However, action taken on the recommendations of the Indian Education Commission (1882-83), Royal Commission (1881-83), and Resolution of 1888 and of 1897 led to introduction of some kind of science in school education by the first decade of present century. The course of instruction in primary school, as pointed by Nathan (1904), was conceived with a view:

> To teach the child to read and write his own language to obtain sufficient knowledge of arithmetic and mensuration to enable him to do every sums, and to understand the simple forms of native accounts and the village map; to acquire a rudimentary knowledge of geography, agriculture sanitation and of the history of his country. (Progress of Education in India p. 158)

The teaching of Geography, Agriculture and Sanitation were thus beginning of elementary science at primary level. At the secondary level, in the course of elementary science two valumes of Mac Millan's science primer series, Belfour Stuarts Physics, and Rascoe's Chemistry, were prescribed in Madras. In Central provinces, even in the vernacular schools, Sanitory Reader, Agriculture Reader, Physics Primer were prescribed as compulsory subjects of study. Another significant event at the beginning of present century was the introduction of science at the school stage by the Punjab University. In 1900, it instituted an entrance examination in science parallel to the entrance examination in arts, and a school final examination called the Clinical and Commercial examination. This course consisted of English, Mathemtics, History and Geography, Physics and Chemistry including the elementary principles of Mechanics and Hydrostatistics, as compulsory subjects and Botany and Zoology, Agriculture, Drawing as one of the optionals. (Ibid., p. 121) Thus at the beginning of the present century science had made inroads into the Course of Studies at school education level.

It was at the beginning of the present century again that the state of education in India came under a comprehensive review at the initiation of Lord Curzon. The famous Simla, Conference of Director of Public Instructions (DPIS) took a number of resolutions (156 to be exact) drafting of which has been alleged to be scrutinized by Lord Curzon himself (Basu, p. 6) The conference was followed up by the appointment of the Indian University Commission (1902). The recommendation of the conference and the Indian University Commission resulted in the issue of the Government of India (1904) Resolution on Indian Educational Policy in March 1904, which took note of the shortcomings of the existing situation in school education that "four villages out of five were without a school; three boys out of four grew up without education, and only one girl in forty attended any kind of school. (Indian Educational Policy. (1904), par. 8)

Science Courses for Primary Schools

Curzon felt, as pointed out by Naik (1964), that "the traditional curriculum could be regarded as suitable for urban areas only: and that whatever its merits, it did not meet the needs of the agriculturists of rural areas. (Objectives Curricula and Methods of Teaching 1800-1937, p. 47) The Resolution on Indian Educational Policy (1904) affirmed that:

> Primary education is the instruction of the masses in such subjects as best stimulate their intelligence and fit them for their position in life. . .the courses for rural schools should be somewhat differentiated from those for urban schools. The aim of the rural school should be, not to impart definite agricultural teaching but to give to the children a preliminary training which will make them intelligent cultivators, will train them to be observers, thinkers, and experimenters in however humble a manner. . . The reading books prescribed should be written in simple language . . . and should deal with topics associated with rural life. (Government of India (1904). par. 8)

Some attention appears to have been paid to these ideas in almost all parts of the country. In particular attempts were made to introduce nature study, school gardening and agriculture in rural schools. These attempts did not succeed as pointed out by Naik (1964) because "there were immense difficulties in getting equipment, land and trained teachers. A more serious difficulty, however, arose from the fact that a common curricula for both rural and urban areas tended to create a gulf between the urban and the rural school—the former teaching more language, Arithmetic and English, led to secondary schools, and careers, while the latter, which was devoting a good deal of time to agriculture led no where. The rural population resented this and desired to have schools which were as like the urban schools as possible (Naik, op. cit., p. 48).

However, science did not get the importance in the curriculla for primary schools. Science was not a compulsory teaching subject except in form of object lessons. It was compulsory only in Bengal. (Naik, 1964. p. 57) The Director—General of Education in India, in 1906 observed:

In India, the tendency (teaching of science) is to think and speech not to observations and action to the subjective, not to the objective. This makes all the more necessary the application of the concrete observational, expressive element as a corrective and at the same time the use of care and delibration in its gradual introduction. We can afford to watch the effect on the rising generation in America of the new principles. (Sharp, 1906. Occasional Report. p. 116)

Voluntary Efforts for Science Education

Indeed, despite Curzon' s major concern for raising the quality of higher education and the increasing domination of universities over school education, the demand for science and technical education at the school level grew. The National Education Movement (1905) took upon itself imparting of Scientific, Professional and Technical Education chiefly in those branches of Science, Arts and Industries which were best calculated to develop the material resources of the country. The fundamental ideals of the Councils scheme were to train students intellectually and morally so as to mould their character according to the highest national ideals, and to train them so as to qualify them for developing the natural resources of the country and increasing its material wealth. It laid emphasis upon the awakening of the powers of observation and thought by means of object lessons, and sought to make education real by insisting on learner acquiring a knowledge of things and thoughts, and not merely words and sentences. (Mukherjee and Mukherjee, 1957. passim)

To make education easy, by imparting it through the medium of the learner's vernacular, the course of study was so arranged as to enable the students to learn in five years that they learnt in seven years under the Calcutta University's scheme. The National Council of Education attempted inclusion in Scientific Education such a knowledge of the scientific truths embodied in oriental learning specially in medical education of such scientific truths as are to be found in the Ayurvedic and Hakimi system. (Ibid., p. 45)

Thus the Council made an attempt to pick the best from our cultural heritage and integrate it with the modern curriculum content. Here it would suffice for us to note that teaching of technology in a modern way was included in classes I & II in the from of object lessons, and laws of Health were added to it in class III. In the lower stage of secondary classes i.e., apart from object lessons, workshop practice and Drawing were also included. In the fifth year the discipline approach of teaching science was recommended i.e., teaching of Physics, Chemistry, Biology, Sanitary Science and workshop practice—a trend which has been in practice in U.S.S.R. since 1931 and which we accepted in 1964 after the recommendations of UNESCO Planning Commission, But much of it later.

Not that our educationists were not seized of the problem of how to impart science education at school stage. In the scheme of National Council of Education the boys were expected to be taught the use of simple tools, clay-modelling, paper cutting, etc., and the preparation of simple models in Cardboard. Throughout the primary course the teaching was expected to be oral as far as possible, without reference to textbooks and upto the fith year of the secondary courses all branches of science-Physics, Chemistry and Biology were proposed to be learnt with the aid of experiments and without textbooks and no written examinations were proposed to be held. Literary and scientific education were expected to go hand in hand with such branches of technical education as may be necessary to prepare the students for his intended career in life (Ibid., pp. 63-66).

Tnus efforts were being made to improve school science equcation at government level as well as voluntary organisation level.

However, the educational position came under review again in 1913 during the period of Lord Hardinge. The Resolution on Indian Educational Policy (1913) directed that "there should be a large expansion of lower primary schools teaching the three R's with drawing, knowledege of the village map, nature study and physical exercises." (Government of India (1913), par. 1)

Thus the teaching of science, from very beginningwas recommended. However, the prevalent policy of different type of curricula for rural and urban schools was changed, within a span of only ten years by recommending a same curricula for rural and urban schools. It was hoped that in the case of urban schools there was special scope for practical teaching of geography, school excursions etc., the nature study to vary with the environment, and some other from of simple knowledge of the locality be substituted for the study of the village map. As competent teachers were become available a greater differentiation in the courses perhaps was possible. (Ibid., par. 9) However, science as a compulsory component of school curriclum was provided in the form of nature study. The teaching of nature study was first included in the curriclum of lower primary schools in 1919 in Bombay Presidency, while in England it was included in 1902 in the lower primary classes I-IV. Comparing the curricula of elementary schools (I-IV) in England and in Bombay Presidency, Parulekar observed:

> That as soon as it was discovered in Bombay that a certain subject was introduced in the schools of England, it was soon prescribed for the Bombay Schools, making the curriculum compulsorily richer and richer and even more in advance of the ordinary English Elementary school curriculum of the time. . . . (Parulekar, Mass Education in India, p. 16)

From this it can be presumed that the school curricula for schools in a few places in India were at par with those of schools in England. Analysing the process of curriculum construction for our schools, Parulekar pointed out that:

> . . . In copying wholesale the English model and superimposing it on Indian schools, the educational administrators hardly took into account the very important fact that the needs of a mainly agricultural country split into numberous villages would not be the same as those of a highly urbanized and industrialised country like England. (NCERT, 1964, p. 46)

Science Courses for Secondary Schools

According to the Resolution on Indian Educational Policy (1904) secondary education courses of study were too literary in their character, almost exclusively preparatory to the University Entrance Examination and that most of the scholars did not proceed to the university. They required some different course of instruction, analogous to what was known in England as a 'modern side', catering the needs of those boys who were destined for industrial or commercial pursuits. The Resolution in Indian Education Policy (1904) noting that attempts had not met success, purely literary course, qualifying as it did both for the university and for government employment continued to attract the great majority of students, "to promote diversified types of secondary education, corresponding with the varying needs of practical life." (Government of India (1904), par. 23)

Accordingly the attempts at providing alternative courses at the upper secondary stage were continued although "the success obtained was hardly encouraging." (Narullah and Nayak, (1951), History of Education in India, p. 341) For instance, at the beginning of the present century in Madras the subjects were grouped in three divisions known as A, B and C. Division A included English Vernacular composition, and translation, and Elementary Mathematics (Examination Subject). Division B included Geography, Indian History, Elementary Science, Drawing Physical Training and for girls Domestic Economy and Needle Work. Finally, Division C included all those subjects, proficiency in one or more of which was necessary for entering the university, a technical institution or business, or were recognised as forming part of a good school education.—Algebra, Geometry, Physics, Chemistry and Botany, English, History, Classical Foreign and Vernacular Languages; Arithmetic, Geography, Agriculture, Music, Needlework, Dress making and Lace making. (Progress of Education in India (1907-12) Nurullah and Naik. 1951. p. 343) Similarly, in United Provinces over and above compulsory subjects—Physics, Chemistry, Botany, Agriculture and Domestic Science were included as optional subjects for school leaving certificate examination.

Thus science subjects were included in the high school curriculum and perhaps, because these subjects were made non-examining subjects that they could neither make any impact nor bring about a noticeable improvement in the school science education.

The Resolution on Indian Educational Policy (1913) recommended diversion of study of courses even for primary and secondary schools for the average scholar to more practical ends, e.g., by means of manual training, gardening, outdoor observations, practical teaching of geography, school excursion, organised tours of instructions, etc. The Policy Resolution (1913) emphasised the need of a secondary school course complete in itself but of a modern and practical character, freed from the domination of the matriculation examination recommended by the Indian Education Commission (1882-83). (Government of India. 1913. par. 24)

Accordingly attempts were made to introduce vocational courses in the upper classes or middle classes of the secondary schools. The Punjab, took step to introduce the teaching of practical agriculture in middle schools. This innovation was adopted in Bombay in the recommendation of a committee on agricultural teaching which met in 1918. (Richey, 1923. Progress of Education in India, p. 100) Richey (1923) observed:

> If experiments of this kind prove successful and if the difficulties in the way of introduction of optional English classes are overcome there may emerge a single type of middle school providing a good general and practical education in the vernacular suitable to the needs of the country by and providing at the same time facilities for the study of English for few who are in a position to go further with their studies. The evolution of such a type of school would go far to solve two of the most pressing of Indian educational problems, the retention of the educational youth on the land and the equivalisation of educational opportunity between the town and country. (Ibid., p. 101)

However, Richey (1923) in the Eighth Quinquennial Review of the progress of education in India 1917-22 described the consequences of such steps in the following manner:

> It is often assumed that the education given in a village school is despised because it is not practical enough. In many cases, however, the parents' objection is just the opposite. He has no desire to have a son taught agriculture partly because he thinks he knows far more about that than the teacher, but still more because his ambition is that his boy should become a teacher, or a clerk. The solution which is so frequently put farward of popularising schools by adapting rural education to rural needs has little or no meaning in the absence of an agreement as to rural needs between the rustic introduction of utilitarian studies such as agriculture into the village school's course. The rustic sends his child to school to learn to read and to write. (Ibid., p. 122)

So the problems of construction of a suitable curricula for urban and rural schools within the resources of the Government persisted. People were neither satisfied with the same curricula for both type of schools nor with different type of school curricula for urban and rural schools.

Be that as it may, during the period 1912-1917, some progress in teaching of science appears to have been made. The following is the description in the progress of education in India (1912-1917) which needs a detailed mention:

> Perhaps the most important change in method has been the improvement of science teaching. This subject is compulsory for the Bombay matriculation, though not as an examination subject. Bombay has now an inspector of science teaching. A curriculum textbooks and teachers manuals had first to be prepared. The subjects thus treated were studies of matter and life for the lowest classes, then physiology and nature study, then physiology and hygiene, then Physics and

> hygiene, then Physics and mechanics and finally chemistry and first aid in the highest class. (Sharp. H. (1918), p. 98)

Not only this, the other components of reforms such as method, individual practical work, list of simple inexpensive experiments and teacher's training were thought of, which was reported to have been very successful as observed in the Eighth Quinquennial Review:

> A list of simple, inexpensive and definite little experiments was drawn up for performance of each boy. Then came the final step necessary for starting the scheme of the training of teachers for instruction in science, which was carried out at four centres and is reported to have been very successful (Sharp. (1918), p. 98).

Calcutta University Commission

Owing to the outbreak of the First World War, the progress of education was arrested and the directions of the Indian Educational Policy Resolution (1913) could not be carried out. At the conclusion of the war, people realised the need of educating the masses. It was also felt that the Indian Universities were not giving right type of education to the 'directing classes, Perhaps, because of this, in 1917, the Government of India appointed a commission popularly known as Sadler Commission to enquire into the condition and prospects of the University of Calcutta and to consider the question of a constructive policy in relation to the question it presented. The Commission while analysing the situation in Bengal, observed that: "It has always been the duty of every father . . . however, poor he might be to see that his sons obtained the kind of education dictated by the traditions of their caste. But the traditional system has been literary in character, even Vaidyas learn medical science from books." (Selected Chapters of the Report, p. 80) Reviewing the past policies and practice of education in India, the Commission considered the emphasis which the educational despatch of 1854 laid upon elementary education, a notable feature, but at the same time observed that the directors, "assuredly did not intend that their system should be so narrowly conceived as it came to be in practice." (Ibid, p. 91) The despatch emphasized the importance of "communicating useful and practical knowledge urging the teaching of practical agriculture in schools." (Ibid, p. 93) Taking note of the educational situation, the Sadler Commission observed that, "a new kind of education is needed to fit young Bengal for the new kinds of work which it is in the interest of themselves and of their country that they should be better prepared to undertake," (Ibid, p. 157) and suggested a new departure in secondary and higher education of Bengal. The Commission recommended an 'intermediate stage' for university admission instead of matriculation—thus making the twelve years of schooling. The courses of the intermediate colleges, were to be "so framed as to afford preparation not only for the ordinary degree courses of the university in Arts and Science, but also for the medical, engineering and teaching professions and for careers in agriculture, commerce and industry." (Calcutta University Commission, 1919, Vol. V, p. 298).

The Commission recommended the inclusion of "introductory course in science" in the high school curriculum to counteract the bookish and literary tendency of Indian education. But the commission also recommended it not to be a subject for examination. One of its members Mr. J. W. Gregory dissented with this and observed that "after, an interval of five years to allow for provision of the necessary teachers and equipment, the introduction to natural science should be compulsory both in the high school course and in the high school examination." In support of his case making science as an examination subject he quoted the recommendations of Thomson Committee of Great Britain that "it is essential that everybody should be required to pass the examination in science otherwise the subject would be neglected owing to its cost and difficulty, and that the certificate signed by the school master would be an inadequate test". Advocating that "no examination in a subject means no work in it", that "without some kind of examination there would be no incentive to work", that "subjects not examined in are neglected by both teachers and students", and that "without the pressure of an examination the students cannot be made to pay sufficient attention to the subject", Gregory further went on to say that when the subject is new, the teachers inexperienced and the school authorities are disposed to postpone its introduction and avoid its expense . . . unless the examination in natural science be compulsory there are serious reasons to fear that the course will be generally neglected and the important educational benefit expected from it will not be realised." (Report of Calcutta University Commission, Vol. V, passim, pp. 400-427).

Be that as it may, courses in science in the high school curriculum to counteract the bookish and literary tendency on one hand and plea for making it not an examination subject reflected the dilemma of policy makers. The educators who appreciated the educative value of science for developing scientific temper and the beaurocrats who wanted to keep a tap on how teaching was going on took different positions. Education being under the control of Department of Instructions in various provinces, the remedy suggested by Gregory was accepted by many because policy recommendation was one thing and its implementation was another. The effect was that introduction of sciences instead of counteracting the bookish and literary character tended to become literary and bookish Itself.

Looking back during this period, science courses found their place in shool curriculum. Even for primary schools, it was made compulsory in the form of nature study. The controversy of urban and rural curricula in science persisted and there had been vacillations in policy decision. The decision made in 1904 for having separate curricula for rural and urban was countermanded in 1913. Agriculture oriented courses at middle stage were introduced which public did not welcome. National Council of Education (Bengal) tried to pick up the best from our cultural heritage and to integrate it with the science curriculum but it did not succeed.

Diversified curricula were provided at secondary stage but there was little enthusiasm from the public. The debate of visualizing science courses as a counteract of the bookish and literary school curriculum and making it a subject of examination persisted. In implementation of the decision, Department of Instructions in various provinces accepted only whatever was convenient to them in practice.

School Science Education during the Period 1920-1947

The next event of importance in the history of Indian Education was the transfer of the Subject of education (except for domiciled Europeans and Anglo-Indians) to the control of Indian Ministers of Education appointed under the Montague Chelmford Reforms (1921) which introduced dyarchy in provincial administration. The governance of the provinces was divided into two. The Reserved Subjects and the Transferred Subjects. The reserved subjects were administered by Governor of a province with the help of the Executive Council, consisting of some official members, and was responsible to the Secretary of state through the Government of India. The transferred subjects were administered by Ministers elected and accountable to the legislature. Education was one of the transferred subjects.

School Science for Elementary Classes

Provincial legislatures expressed a keen interest in educational problems like compulsory primary education, vocational education, women's education and the like. Public education being a direct responsibility of ministers, provided them with an opportunity to develop and improve the educational system. However, the situation did not improve much. For instance, Little Hailes (1929) suggested that in primary schools the subject matter taught and the methods of instruction ought to bring the work of a primary school into the closest relation with the life and experience of the people. In middle schools, the central subject of study suggested was rural science which ought to coordinate and vitalise various subjects that were then included in the curriculum. Regarding the educational situation the D.P.I., Bombay observed that "the teaching in rural schools is not adopted to the needs of the rural population . . . the ordinary curriculum of the upper primary course is admittedly of a literary character and is quite unsuited to the needs of the children of agricultural class." (Progress of Education in India, 1922-27, p. 144). Government in 1923 sanctioned an alternative curriculum (Agriculture Bias Course) the object was to give a school education with a special bias towards agriculture.

Such attempts too did not bring a change in the desired direction for instance, as pointed out by Naik:

> The teaching methods of the indigenous schools were generally crude and based upon long and continuous drill and rote memory. When the new elementary schools were started the teachers were the persons who had received their early education in the indigenous schools; and, as no other training had been given to them, they unconsciously adopted the methods of teaching in elementary schools to which they were accustomed. (Naik, 1964. p. 49)

Even in case of science oriented subjects, according to Naik, "the same methods were extended without a change. A concept, like the earth is round, was taught by making the boys learn by heart the seven different proofs to show that the earth is round." (Naik, 1964, p. 49).

The Auxillary Committee of the Indian Statutory Commission

Educational progress made since the transfer of Education to the control of Indian Ministers under the Montague-Chelmsford reform was reviewed by the Auxillary Committee of the Indian Statutory Commission commonly known as the Hartog Committee (1929). It observed that "throughout the whole educational system there is waste and ineffectiveness", (Report, p. 345) and felt the need of "a well directed policy carried out by effective and competent agencies determined to eliminate waste of all kinds." (Ibid, p. 346) The Committee, while taking note of the fact that with the reforms of 1920, Education became a 'transferred' subject and Government of India regarded all responsibility of educational policy as developed on the separate provinces and that an educational policy for India as a whole no longer existed, desired a national education policy.

Comparing the demographic pattern of England and India, Hartog Committee noted that whereas seventynine per cent of population in England was urban, in India it was about thirteen per cent only. Therefore, it viewed the problem of mass education in British India, as being "preponderantly a rural problem", which colud be surmounted if a 'concerned effort' was made "to made the school as instrument of village 'uplife', economic and social as well as intellect." While pointing out the recommendations of the Royal Commission on Agriculture that "it is essential to the happiness and efficiency of children in the villages that their upbringing should be in harmony in with their environment, and to this it is most desirable that every element in the education they receive in their village schools should draw strength and inspiration from the life of the countryside", (Report of the Royal Commission on Agriculture, p. 513), the Hartog Committee took note of welcome signs that "attempts are being made in most provinces to review curricula of vernacular schools so as to bring them and the methods of teaching into greater harmony with the needs and conditions of village children". Though the Hartog Committee took a dark view of the possibilities of having an extended primary school curricula in as much as it opined that "little can be attempted at present beyond instruction in reading, writing and elementary arithmetic and while the need of extending literacy, is so great that for some time "three R's and no nonsense" must be the motto of the schools". It appears that Hartog Committee did not recommend the teaching of science in village schools. However, it was aware of the fact that the great majority of the villages were in urgent need of better conditions of life, better sanitation, medical relief, freedom from debt and social and intellectual awakening. The Committee, therefore, felt that "the aim of every village school should include not merely the attain-of ment literacy but the larger objective, namely the raising of the standard of village in all aspects". Accordingly it envisioned that "a well attended school directly related to the surrounding conditions can do much towards training the younger generation in ways hygiene, physical culture, improved sanitation, thrift and self reliance, (Report, passim 5,18,37,78) in a way general education.

The United Province's Unemployment Committee

The United Province's Unemployment Committee (Sapru Committee) which was appointed by the U.P. Government in 1934, to go into question of unemployment among educated youngmen, and to suggest practical ways and means for reducing the same, examined the problems of education and felt the need to bring education into line with the needs of the country. "There must be some correlation between education and the use that is going to be made of the educated product," while suggesting that "in future education and unemployment must be viewed together" it recommended that "while it should be the aim of primary education, to remove illiteracy it should also be its principal aim to qualify boys to become better agriculturists and more useful members of village communities." (Report, p. 253) The Committee did not suggest anything about school science.

Abbot-Wood Report

Central Advisory Board of Education (1935) suggested to invite expert advice for a radical readjustment of the existing system of education, i.e., reorganisation of educational system.

Accordingly, the Government of India made a request for a team of ten experts to be divided into five groups of two each one with a knowledge of urban and the other of rural educational problems to be selected by the Board of Education from among suitable persons in England, to cover whole of India. Only two experts could be made available who 'limited their investigations' to three provinces—Delhi, the Punjab and the United Provinces during 1936-37 and submitted their report, to advise the Government "whether any vocational or practical training should be imparted in primary, sceondary and higher secondary schools and if so, what should be its nature and extent, and on certain problems of educational reorganisation and particularly on problem of vocational education." The Abbot-Wood report (1937) recommended:

> The education of children in the Primary Schools should be based more upon the natural interests and activities of yougn

> children and less upon book-learning. Concentration on literacy as a narrow objective was unsound. (Report, p. 13)

In the case of lower secondary education, the two experts Abbot-Wood while making recommendations with regard to General Education, percieved rural middle school important because they regarded it as potentially the most significant educational institution in a country in which about ninety per cent of the population lived in areas and that "the curriculum of the rural middle school (or Lower Secondary School) was to be closely related to children's environment." (Abbot-Wood report, p. 33)

This recommendation, it appears again led a confusion—having separate curriculum for rural schools which the public in the past did not welcome. Moreover, the implication of this recommendation appears to teach science according to General Science approach. The debate of having different curricula for science course for rural and urban schools also persisted.

Basic Education System

The provinces were given popularly elected assemblies on account of the Government of India Act 1935 in which ministers though appointed by the governors were responsible. The first election under the new franchise was held in 1937 and as pointed out by Sargent "the new provincial ministries were soon in satisfactory working order." (Sargent, 1968. p. 20) The Indian people themselves had an opportunity to reflect upon the pattern of school education. Mahatma Gandhi placed an educational scheme popularly known as Basic Education before the country "primarily for the villages", (Educational Reconstruction, p. 63) which as observed by Naik (1964) "was the one answer to India's needs in elementary education," (op. cit. p. 49) and as observed by Sargent (1968) "one of the most important events in the history of Indian education." (op. cit. p. 80) Mahatma Gandhi observed that "the existing primary education was admittedly a snare and a delusion." (Educational Reconstruction,

p. 9) He was dissatisfied with the way teaching of science was being done in schools. He observed:

> Science as taught today in schools tends to be dry and dull. Our children cannot make much use of what they are taught in this field. A science like astronomy which should be taught to the boys in the open by actually showing them the stars in the sky is taught through books. I do not think many boys remember how to analyse water into its components once they leave school. (True Education, p. 28)

Mahatma Gandhi pointed out the neglect of subjects such as Agriculture. (Ibid, p. 29) Emphasizing the need of coherence between education and environment he said that "there must be accord between the education a child receives at school and the environment of the home." (Ibid., p. 40) In science teaching, Mahatma Gandhi, valued much the process rather than the content. He observed that "everything can be turned into science . . . if there is a scientific spirit behind it." (Ibid, p. 90) His ideas were given shape into the scheme of Basic Education which was chalked by Zakir Hussain Committee to show how his ideas could be translated into practice and what exactly the boys and girls would learn from year to year. Zakir Hussain Committee was, perhaps, the first committee of its kind on elementary education which envisaged a new pattern of elementary education for the whole nation. Most of the earlier Commissions, Committees, mainly dealt with either secondary or higher education or both and just touched upon elementary education. The Zakir Hussain Committee pointed out that:

> Indian opinion is practically unanimous in condemning the existing system of education in the country. In the past it has failed to meet the most urgent and pressing needs of national life, and to organise and direct its forces and tendencies into proper channels . . . There is, therefore, a demand from all sides for the replacement of the present system of education by a more constructive and human system, which will be better integrated with the needs and ideals of national life,

and better able to meet its pressing demands. (Committee Report, p. 8)

Keeping in view the resolutions made at Wardha Education Conference (1937) that free and compulsory education be provided for seven years on a nation-wide scale, the medium of instruction be the mother-tongue, the process of education throughout this period to centre around some form of manual and productive work, that all the other abilities to be developed or training to be given as far as possible, be integrally related to the central handicraft chosen with due regard to the environment of the child, and the system of education be gradually able to cover the remuneration of the teachers', (Ibid, pp. 110-111) and in order to work out an effective and natural coordination of the various subjects and to make the syllabus a means of adjusting the child to his environment, the Zakir Hussain Committee chose three centres, intrinsically inter-related, as the focii for the curriculum viz., the physical environment, the social environment and craft work—which was conceived as the natural meeting point since it utilised the resources of the former for purposes of the latter. (Zakir Hussain Committee, Report, p. 66) The Zakir Hussain Committee attempted to draft an 'activity curriculum' which implied schools to be the places of work and experimentation and discovery, not of passive absorption of information imparted at second hand. The subject matter was organised into significant and comprehensive units of experience when mastered could enable the child to understand his environment better. The teaching, as committee suggested was to be carried on through concrete life situations. (Ibid, p. 67)

The teaching of science—'nature study' in the lower classes was to be centred round the different seasons which provided a starting point for observing natural phenomena through active personal observations, excursions, gardening, lending of pets and survey of the locality. In general outlines, the same syllabus of studies was suggested for boys and girls upto the fifth grade of the school. In grades four and five, the syllabus in general science was to be so modified as to include domestic science for girls. In grade six and seven, the girls were expected to take an advanced course in domestic science in place of basic craft. (Ibid, p. 26)

The objectives of general science course envisaged in Basic Education Scheme were:

- —to give pupils an intelligent and appreciative outlook on nature,
- —to form in the pupils habits of accurate observation and of testing experience by experiment,
- —to enable them to understand the important scientific principles exemplified in the natural phenomena around, and the application of science to the service of men and to introduce them to the more important incidents in the lives of the great scientists whose sacrifices in the cause of truth make a powerful appeal to the growing mind. (Ibid, p. 26)

The curriculum of General Science included the following topics from various sciences:

I. Nature Study

(a) A knowledge of plants, crops, animals and birds in the environment.

(b) A knowledge of the changes of seasons and their effect on the activity of plants, animals, birds and man.

(c) A knowledge of crops in different seasons.

II. Botany

(a) Different parts of plants and their functions.

(b) Process of germination, growth and propagation.

(c) Work on the school garden and the fields around to give the pupils an understanding of the effects of differing conditions of moisture, heat and light, and of the different qualities of seeds and manures.

III. Zoology

A study of germs, insects, reptiles and birds as friends and foes of man.

IV. Physiology

The human body, its organs and functions.

V. Hygiene

(a) Personal hygiene: cleanliness of teeth, tongue, nails, eyes, hair, nose, skin, clothes.

(b) Cleanliness of the home and the village, sanitation, disposal of night-soil.

(c) Pure water; the function of trees in its purification; proper breathing.

(d) Food, hygienic and unhygienic; balanced diets.

(e) First aid and simple remedies.

(f) Common infections; contagious diseases; how to safeguard against them.

(g) Purity of conduct as a preservative of health.

VI. Physical Culture

Games, athletics, drill (Deshi games to be encouraged).

VII. Chemistry

Chemistry of air, water, acids, alkalis and salts.

VIII. Knowledge of the Stars

Knowledge of the stars showing direction and time at night.

IX. Stories

Stories of the great scientists and explorers and their contributions to human well-being. (Ibid, p. 26, pp. 65-77)

If we look the position of science teaching at elementary stage in America during 1920s and 1930s we find that criticism of conventional subject curriculum gave rise to the 'activity or experience curriculum'. The criticism gave rise to another design of curriculum—Broad Fields Curriclum—by combining several specific areas into larger fields. "History, Geography and Civics were combined into Social Studies. The first courses in General Science were composed of special sections of Chemistry, Botany, Zoology, Astronomy and Geology." (Taba, 1962. p. 393) It appears that the content of General Science envisaged in basic education might had been influenced by American thinking. Not only the curriculum, but the methodology appears to have been influenced by American thinking. Singh (1970) also observed that "Gandhi's educational thinking shows marked resemblance to Dewey's views . . . American ideas have been sought after eagerly on a purely voluntary basis" (American Influences on Indian Education, p. 16) Thus it appears science content in basic education curriculum seems to have a marked resemblance to American concept of General Science.

Be that as it may, science under the name of General Science found place in Basic Education Scheme. The time allocated for the science teaching was fifteen minutes out of the total time five hours thirty minutes per day. The school was expected to work for two hundred and eightyeight days in a year. (Zakir Hussain Committee, p. 37) Due to the Second World War and Non-Cooperation Movement, the scheme of basic education made a little headway.

Position of Science Teaching in Schools

As already discussed, the science content and its teaching differed in different provinces. Since 1920, there was no longer any National Policy on Education in the country. There is no study available at national level which may reveal the position of existing science teaching at National level. However, an idea may be had from the following comments of the Director of Public Instruction of Uttar Pradesh:

> Nature study forms part of the general science course which is taught in all classes from III to VIII and includes elementary science and hygiene. As to nature study itself, the Inspector of Benaras observes "at present its teaching is generally confined to the preparing of small plots and growing a few seedlings and observing their growth." From Bareilly comes the report that "the subject is being reduced to the textbook type, Lucknow reports that the subject is not well taught and the boys are bored by it because it is not interesting." The difficulty here of course is that most teachers come from urban areas where they have had no experience of flowers or plants and they do not take kindly to gardening nor have they been ever taught to study nature either in the form of weather, trees, flowers, plants, birds or beasts. The course they have to take at the training college is unreal to them and they soon forget it and take their knowledge from books and not from their own observations. With the great traditions of the Moghul flower gardens to inspire them it is strange that the people of the United Province as a whole are not interested in flowers except perhaps as component parts of garlands. This Naturally from very start puts an obstable to interest in nature study. (Powell Price, 1938. p. 50).

Powell Price further observed:

> Compulsory general science in the upper middle classes . . . no opportunity for practical work. While it left the high school course much too truncated still continues. Further as stated by the Inspector, Lucknow, sufficient attention is not paid to practical work due to the abolition of the practical test in the High School Examination. More schools are taking the general science course for the high school examination which includes biology. (Ibid, p. 50)

From the quotation it may be concluded that the teaching of science in schools was not satisfactory.

National Planning Committee

The courses proposed under Basic Education System were examined by the National Planning Committee (1938) under the Chairmanship of Pandit Jawaharlal Nehru appointed by Indian National Congress. The Committee visualised school curriculum as the modus operandi for adapting the school children to their natural environment, social environment and the technology (craft) which would help them to live a 'constructive' life. It found "the syllabus prescribed by Wardha Scheme appear to be rather ambitious for the children below the age of fourteen, and recommended that "science taught in the primary schools should be of a descriptive nature" (Report, p. 148), in contrast to 'activity curriculum' of Basic Education, and observation lessons. It may be mentioned here that the Committee examined the science teaching in USSR and did not favour it observing that "the experiment has proved a failure because the students thereby acquire only a superficial knowledge of the science and can not apply the sciences to need problems. They become so-called practical engineers able to maintain a running concern but unable to cope with unforeseen difficulties and suggest new developments." (Ibid, p. 148).

Post War Educational Development in India (1944)

The soundness of the underlying principles of basic education impressed itself on the Government of the day. The Plan for Post-War Educational Development (1944), popularly known as Sargent Plan, except for the self-supporting aspect, accepted the principles underlying basic education (Sargent Plan, p. 12). It accepted Basic Education pattern for the country for all boys and girls between the ages of six and fourteen (Fourteen plus was also the age limit for compulsory education in Great Britain.) in two stages; junior basic for five years and senior basic for three years. The Sargent Plan also approved the general science pattern for elementary schools which has already been discussed earlier. For the middle stage, it suggested a provision for a variety of courses extending over a period of five years after the age of eleven. These courses while preserving an essentially cultural character were to be so designed as to prepare the pupils for entry into industrial and commercial occupations as well as into the universities. (Sargent Plan, p. 13) The Sargent

Plan recognised the importance of science teaching in schools and opined that "all pupils should also acquire some knowledge of mathematics and elementary science." (Ibid, p. 22)

School Science for Secondary Schools

As discussed earlier, the Auxillary Committee of the Indian Statutory Commission—Hartog Committee reviewed educational progress covered by political reforms which were initiated in 1921. Contrary to the state of education of the masses, the Hartog Committee found that education of the Directing Classes, i.e., the system of secondary and higher education designed to produce competent and trustworthy representatives and officials, was well advanced. (op. cit., p. 90) The Committee observed:

> While the condition of mass education must cause grave concern, secondary education is, by contrast, well advanced so that, although there are many defects in the system, it is already making a real contribution towards the building up of a directing class. (Hartog Committee, p. 90)

Discussing the educational situation the Hartog Committee took note of the uniformity of the system of high and middle English schools throughout country and observed that "all sections of the community, with their different ambitions and aptitudes, have little, if any, choice of the type of school to which they will send their children." (Ibid, p. 104) In fact the then English middle and high school had entranced itself so well that other forms of schools were either not trusted or opposed, and there was a marked tendency to regard the passage from the lowest primary class to the highest class of a high school as the normal procedure for every pupil. The Committee observed that "there is nothing corresponding to the exodus from many English Secondary Schools either into practical life or into a vocational institution." (Ibid, p. 104)

It was evident that a large number of boys were wasting time, effort and money by following the existing course in the secondary classes and that the "waste was pitiful." (Ibid, p. 106)

The Hartog Committee, keeping in view the fact that a large number of pupils in high schools would be benefitted by being in schools of another type, suggested "the retention in the middle vernacular schools of more of the boys intended for rural pursuits, accompanied by the introduction of a more diversified curriculum in those schools." (Ibid., p. 107)

Mentioning that "nearly seventyfive per cent of the total population was dependent on agricultural occupation, the creation of a suitably devised educational system for the rural areas was the first importance. It was essential to adopt the scheme of rural education to rural conditions and requirements." (Ibid., p. 107) Making mention of the Punjab Government circular of 1923 the Hartog Committee reaffirmed that the aim was to enrich the middle school course in rural areas by the inclusion of agricultural training and thus to bring it more in keeping with the environment of the pupil, object being to use agriculture as a means of mental discipline and training and as an important necessity to the general subjects taught in these schools. It, therefore, suggested "the inclusion of teaching in elementary principles of improved village sanitation and of the maintenance of cooperative societies, and in other subjects calculated to improve the well-being of rural areas." (Ibid., p. 108)

Thus the committee thought of remodelling of middle vernacular schools to provide 'middle pass' primary school teachers, soldiers, policemen, postmen, builders, farmers and other artisans. The other remedy suggested was, the diversion of more boys to industrial and commercial careers at the end of the middle stage, for which provision should be made by alternative courses in that stage, preparatory to special instruction in technical and industrial schools." (Ibid., p. 107)

The Committee also thought, perhaps, rightly so, that it was unreasonable to compel a boy to undertake a secondary school course which led to the matriculation examination dominated by University requirements whose bent was to industrial rather than rural pursuits. The Committee observed:

> It is the exception rather than the rule to find in India an educational system in which the industrial and the ordinary schools are regarded as complementary to each other. All pupils, whatever be their aim of life, should first receive general education, but it should be opened to boys at some suitable stage in the subsequent course to branch off to craft-schools or to vocational classes. (Ibid., p. 111)

As an illustration of the lack of adjustment between the industrial and the ordinary system, the Committee pointed out "that the industrial primary schools such as, it exists in some provinces implies a misdirection of effort since it is premature for small children of six or seven years of age to receive training in a trade or craft." (Ibid., p. 111)

Commenting on the Central Government's position on educational matters, the Committee observed:

> We are of the opinion that the divorce of Government of India from education has been unfortunate, and, holding as we do that education is essentially a natural service, we are of opinion that step should be taken to consider a new relation of the Central Government with this subject. (Ibid., (p. 346)

United Province's Unemployment Committee

As discussed already that a large number of students going out of the educational system were unable to secure employment of the kind for which the education qualified them. The mass of unemployment amongst the educated classes occasioned such disquiet. In Uttar Pradesh, in the Education Department Government issued, in August, 1934, an important Resolution on the reorganisation of Secondary Education. The Board of High School and Intermediate Education discussed it. The Government of India and the Inter Universities Board discussing the same question, in January, 1945, the Government of India issued an important letter:

> There is a general agreement towards a reorganisation of the distribution of students between the various stages of education. The primary middle and high (secondary), Intermediate (Higher Secondary) and university stage; and that a change in the content of education is necessary in other words, education should. be more practical and vocational leading immediately to employment. (United Provinces of Agra and Oudh Public Instruction—General Report. (1934-35) p. 23).

As pointed out earlier, a committee to investigate the causes and remedies for unemployment was apointed under the distinguished Chairmanship of Rt. Hon. Sir Tej Bahadur Sapru. Sapru Committee concluded that "the prevalent system of education prepared only for examinations and degrees and not for a vocation in life," and recommended that "the High School Examination should have two kinds of certificates—one certifying completion of the course of secondary education and qualifying for admission to Arts and Science Intermediate College." (Sapru Committee. op. cit.. p. 192) The Intermediate course, if the High school course was curtailed by one year, was to be extended to three years and had to four parallel types: (1) Industrial, (2) Commercial (3) Agricultural and (4) Arts and Science. The Sapru Committee was of the opinion that "our Secondary schools should provide such more diversified courses of study, care being taken to give more practical than theoretical education to our boys," and achieve this, the Committee suggested that "the Industrial Courses in Secondary Schools should aim of giving technical training of General Character designed to develop skill of hand and eye and cultivate practical aptitude so as to predispose them towards industrial life." (Ibid., p. 193) Here it may be suffice for us to note that Sapru Committee, keeping in view the other Government Resolution and Inter University Board, recommended eleven year schooling in contrast with the earlier recommendedation of Sadler Commission for twelve year schooling.

Post-War Education Development in India

As discussed earlier, after Second World War, a plan Post-War Educational Development in India (Sargent Plan) was prepared for the consideration of the CABE's meeting 1944. Since the primary object of this plan was to place 'a practicable of post-war development for education' before Reconstruction Committee, the Board had "aimed at a standard comparable with those already attained in Great Britain and other Western countries before war." (Sargent Plan, p. 1) The Sargent plan suggested the abolition of intermediate classes which were recommended by Sadler Commission. The Sargent Plan observed:

> The present intermediate course should be abolished, ultimately the whole of this course should be covered in the high school but as an immediate step the first year of the course should be transferred to high schools and the second to universities." (Op. cit. p. 35).

The function of the school accordingly to the Sargent Plan was "to cater for those children who are well above the average in ability" and accordingly it suggested that "the reorganised high schools should be of two main types—(i) the Academic High Schools to impart instructions in the arts and pure sciences and (ii) technical High Schools to provide training in the applied sciences and in industrial and commercial subjects. (Sargent Plan, pp. 22-23) Here it may be noted that the Sargent Plan recommended ten year schooling as against the earlier recommendations of eleven year/twelve years of schooling. This is another instance of vacillation and uncertainty in policy regarding the duration of schooling.

Review

Looking back, modern science was introduced in India, by the European naturalists, medicalmen, engineers and other technicalmen. It became a part of curriculum at higher stage due to the efforts of a few individuals who expounded the cause of imparting 'useful knowledge' of sciences. The vernacular schools which were sometimes perceived 'as the only way to educate India' remained by and large neglected.

During the earlier period, there emerged two types of education—one imparted in the indigenous schools such as, tols, pathslalas, maktabs, and madarashas and other in schools managed by missions and societies. The British Government proclaimed the improvement of native population as its object and directed to appoint English teachers to teach science. The learned native was visualised as one who knew the physics of Newton. It accepted the responsibility to educate a few who it hoped would form a class of interpreters between the rulers and the millions to be governed. Even though, later, the educational despatch of 1854, imposed the responsibility for education of the masses on the Department of the Administration for the Work of Education yet there was litttle development in school science education and these directions remained just on paper.

After the imposition of Imperial Authority on India, English language was adopted as the medium of imparting instructions in science. So only those persons had access to learn modern science who studied in English medium schools. The position of science teaching in schools was not found to be satisfactory. The Indian Education Commission (1882) recommended the inclusion of science and its applications in the curriculum right from primary classes. Its recommendations were so flexible as to be interpreted either way, inclusion of science—elements of Natural and Physical sciences and their applications on one hand and simplification, i.e., reduction of content on the other.

Again, the decisions made in 1904 for having separate science curricula for urban and rural schools was countermanded in 1913. Efforts were made to introduce agricultural courses right from the middle classes which were not welcomed by the people. The National Council of Education (Bengal) tried to pick up the best from our scientific cultural heritage and tried to integrate with the school science curriculum but it did not succeed for the one reason or the other. Though science was made compulsory in upper classes but it was not made an examination subject.

Not finding the education of the masses in a satisfactory state, Hartog gave the motto of school as being "Three R's and no nonsense" which implied no science teaching in rural schools. Again, in 1937, the education of children in primary schools was as suggested by Abbot and Wood to be based more upon the natural interests and activities of young children and less upon bookish learning, which implied the separate curricula of rural and urban schools and which was in contrast with the recommendation of 1913. Thus there were vacillations in school science policy and the debate of having the same or different curricula for rural and urban schools continued. Though Basic Education emerged as 'one answer to India's needs in elementary education' and 'one of the most important events in the history of Indian education' it did not achieve much success. The general science syllabus framed according to National Basic Education Scheme was by and large influenced by the thining, content and methodology popular with American Schools. For instance, curricular design of General Science had a marked resemblance to Broad Fields curriculum design. According to National Planning Committee (1938) the syllabus was 'ambitious' and was beyond the capacity of children and teachers. The Committee recommended the teaching of science through an alternative approach which it called 'descriptive approach'. Subsequently, the Sargent Plan recognising the importance of science recommended teaching of elementary science to all pupils. Inspite of all this not much could be achieved in the area of school science education. But, in contrast with mass education, science education at the secondary and higher education stage appeared to be 'well advanced'. The tendency was to keep the science curriculum at par with the existing curriculum being followed in Britain.

Not only school science policies changed frequently but also the school structure changed. Duration of schooling changed from ten years (1854) to twelve years (1917) and from twelve years to eleven years (1934) and again to ten years (1944). The necessity of having a national education policy was felt at all levels and the 'divorce' of Government of India from education was percieved as 'unfortunate'.

Thus, during the British period, one can find vacillations, uncertainty and aimless compromise both in making a school science policy and in its execution. Decisions, recommendations once made were countermanded a few years later. Policy lines were so ambiguous as to leave a latitude for local interpretations obstructing introduction of science education for the masses, on one pretext or the other. The main problem for the introduction of science in school education system had been a lack of clear-cut, consistent and effective science education policy both in its making as well as in its implementation, for the great majority of our people.

REFERENCES

Abbot, A and Wood, S. H., 1937, *Report on Vocatioual Education*. Delhi: Manager of Publications [Printed by the Manager, Government of India Press, Simla].

All India Council for Secondary Education, 1956, *Proceedings of the All India Seminar on the Teaching of Science in Secondary Schools*. New Delhi: The All India Council for Secondary Education, Ministry of Education, Government of India.

Auxillary Committee of the Indian Statutory Commission, 1929, *Interim Report of the Indian Statutory Commission*, Calcutta: Government of India, Central Publication Branch.

Basu, Aparna, 1974, *The Growth of Education and Political Development in India (1898-1920)*. Delhi Oxford University Press.

Bhargava, K. D. (Ed). 1968, *Selections from Educationol Records of Government of India Vol. IV Technical Education in India (1886-1907)*, New Delhi: National Archives of India.

Bhargava, K. D. (Ed.) 1968, *Selections from Educational Records of Government of India Vol. IV (Technical Education in India—1886-1907)*. New Delhi: National Archives of India.

Bose, D. M. et. al., (Ed). 1971, *A Concise History of Science in India*. New Delhi: Indian National Science Academy for the National Commission for the Compilation of History of Sciences in India.

Calcutta University Commission (1917-1919), *Report Vol. V*. Calcutta: Superintendent Government Printing, India.

Calcutta University Commission (1917-1919). *Selected Chapters of the Report of the Calcutta University Commission,* Calcutta Superintendent Government Printing, India (Reprint Edition. 1921).

Chandra, B. 1971, *Modern India* A Textbook of History for Class XI-XII. New Delhi: National Council of Educational Research and Training.

Chowdhury, S. M. H. Rahman, 1980. Socio-economic and Cultural Impact of European Sciences in India in (*Indian National Science Academy, 1980*).

Croft. A. 1888, *Review of Education in India in 1886, with special reference to the Report of the Education Commission.* Calcutta: Superintendent of Government Printing.

Government of India, 1904, *Indian Educational Policy,* 11th March, 1904. Calcutta: Office of the Superintendent, Government Printing India.

Government of India, 1913, *Indian Educational Policy* (*21 Feb. 1913*). Calcutta: Office of the Superintendent, Government Printing India.

Indian Education Commission (1882-83), 1883, *Report of the Indian Education Commission.* Calcutta: Superintendent Government Printing India.

Indian Industrial Commission (1916-18)—cited by (*Nurullah, S. and Naik, J. P. 1951, p. 577*).

Indian National Science Academy, 1980, *Science and Technology in India in 18-19th century.* New Delhi: Indian National Science Academy.

Little Hailes, R. 1929, *Progress of Education in India 1922-27. Ninth Quinquinnial Review, Vol. I.* Calcutta: Government of India, Central Publication Branch.

Mazumdar, A. C. 1915. The Educational Problem. *Indian National Evolution.* Madras: G. A. Natesan & Company. (Second Edition, 1917).

Mukherjee, H. D. and Mukherjee, U. 1957, *The Origins of the National Education Movement.* Caclutta: Jadavpur University, Jadavpur, Calcutta-32.

Naik, J. P., 1964, *Objectives, Curricula and Methods of Teaching* (*1800-1937*) in (*NCERT. 1964*).

Nathan, R. (1904), *Progress of Education in India* (*1897-98*) (*1901-02*) (*Vol. I*), Calcutta: Office of the Superintendent of Government printing India.

National Archives of India, 1960, *Selections from Educational Records of* *the Government of India, Vol. I. (1959-71)*. New Delhi: National Archives of India.

National Planning Committee, 1938, *Education*. (General Education and Technical Education and Developmental Research). Bombay: Vora & Co. Publishers Ltd.

NCERT. 1964, *The Indian Year Book of Education 1964—Second Year Book (Elementary Education)*. New Delhi: NCERT.

Nurullah, S. and Naik, J. P.., 1951, *A History of Education in India*. Bombay: Macmillan and Co. Ltd.

Parulekar, R. V., *Mass Education in India*. (in NCERT. 1964).

Powell Price, J. C., 1938, *General Report on Public Instruction in the United Provinces for the Quinquennium ending, March 31, 1937*. Allahabad: Superintendent, Printing and Stationary United Provinces India.

Richey, J. A., (Ed.) 1922, *Selections from Educational Records 1840-1859 (Part II)*. New Delhi: National Archieves of India (Reproduced in 1965).

Richey, J. A., (1923), *Progress of Education in India (1917-1922)*. Calcutta: Superintendent, Government Printing India.

Royal Commission in Agriculture in India, 1928, *Report of the Royal Commission on Agriculture in India*. Bombay: Government Central Press.

Sargent, J. 1968, *Society Schools and Progress in India*. Pargamon Press.

Sharp, H. 1906, *Occasional Reports No. 4* (Educational Studies at the St. Louis Exposition). Calcutta: Office of the Superintendent, Government Printing.

Sharp, H., 1918, *Progress of Education in India, Seventh Quinoquennial Review (Vol. I)*. Calcutta: Superintendent Government Printing, India.

Sharp, H., (Ed.) 1920, *Selections from Educational Records (1781-1839) Par. I.* New Delhi: National Archives of India (Reproduced 1965).

Singh, R. P. 1970, *American Influences on Indian Education* in (NCERT. NIE Journal. Vol. IV, No. 3.)

Subbrayappa, B. V. 1971, Western Science in India upto the end of the Nineteenth Century AD in (*Bose, D.M. et. al., (Ed.), 1971*).

Taba, Hilda. 1962, *Curriculum Development*. New York: Harcourt, Brace and Word. Inc.

United Provinces of Agra and Oudh Public Instruction. *General Report (1934-35)*. Allahabad: Superintendent. Printing and Stationary United Provinces.

United Province's Unemployment Committee. 1936. *Report of the Unemployment Committee United Province (1935).* Allahabad: Printing and Stationary United Province.

Vakil, K. S. and Natrajan, S. 1966 (Revised Edition). *Education in India.* New Delhi: Allied Publishers.

Zakir Hussain Committee. *Basic National Education—Complete Syllabus for Grades I to VIII.* Sevagram (Wardha): Hindustani Talimi Sangh.

Anderson, George. *Progress of Education in India, 1927-32 Vol. I.* Delhi: Manager of Publications.

Bryant, C. L. 1936, The Teaching of General Science—*Interim Report of the Sub-Committee of the Science Master's Association,* London.

CABE. 1939, *Report of the Committee of the CABE Appointed to Consider the Wardha Education Scheme.* Delhi: Manager of Publications (Government of India).

CABE. 1939, *Report of the Second Wardha Education Committee of the CABE.* Delhi: Manager of Publications, Government of India.

CABE (1935-1960). 1960, *Silver Jubilee Souvenir.* New Delhi: Ministry of Education (Government of India).

Casewell, Hollis L. and Campbell Doaks. 1935, *Curriculum Development.* New York: American Book Company.

Craig, Gerald. S. 1932, The Programme of Science in Elementary Schools. *The Thirtyfirst year-book of the National Society for the Study of Education Part-I.* Bloomington Public School Publishing Co.

Dewey, John: 1956, *The Child and the Curriculum.* New York: MacMillan & Company.

Hartog, P. 1939, *Some Aspects of Indian Education—Past and Present.* London Oxford.

Hindustani Talimi Sangh, *Sixth Annual Report* 1938-44. Sevagram Wardha: Hindustani Talimi Sangh.

Hindustani Talimi Sangh. 1940, *One Step Forward. The Report of the First Conference of Basic National Education, Poona—October 1939.* Sevagram (Wardha C.P.): Hindustani Talimi Sangh.

Hindustani Talimi Sangh. 1942, *Two Years of Work.* Report of the Second Basic Education Conference. Sevagram Wardha (C.P.). Hindustani Talimi Sangh.

Hindustani Talimi Sangh. *Report of Nai Talim (1938-46).* Sevagram Wardha: Hindustani Talimi Sangh.

Hindustani Talimi Sangh. 1950, *Report of the Sixth All India Basic Education Conferenc*: Sevagram: Hindustani Talimi Sangh.

Mc Murry, Charles A. 1927. *Special Method in Elementary Science for the Common School*. London: The MacMillan Company.

Nash, A. M. 1893, *Progress of Education in India, 1887-88—1891-92.* (Second Quinquennial (Review). Calcutta: Office of the Superintendent of Government Printing, India.

Piggott Committee on Primary Education *Resolution and the Report*. Allahabad: Superintendent, Govrnment Press United Provinces.

Piper, Charles J. 1932, Science in the Seventh, Eighth and Nineth Grades —*The Thirty-first Yearbook of the National Society for the Study of Education, Part. I.* Bloomington Public School Publishing Company.

Powers, S. Ralph. 1932, Some Criticism of Current Practices in the Teaching of Science in Elementary and Secondary Schools—*The Thirtyfirst Yearbook of the National Society for the Study of Education Part-I.* Bloomington Public School Publishing Company.

Primary and Secondary Education—Reorganisation Committee 1939, *Report*. Allahabad: Superintendent Printing and Stationary United Provinces (India).

Sargent, J. 1940, *Progress of Education in India 1932-1937. Volume I.* Delhi: Manager of Publications Government of India.

Sargent, J., *Progress of Education in India, 1937-1947 Decennial Review, Vol. I.* Central Bureau of Education, Ministry of Education. Government of India.

Shrimali, K. L., 1949, *The Wardha Scheme*, Udaipur: Vidya Bhawan Society.

Siqueira, T. N., *Modern Indian Education*. Calcutta: John Brown Oxford University Press, Mercantile Building (1960).

5

SCHOOL SCIENCE EDUCATION DURING 1947-52

Whenever conferences were called in past to form a plan for education in India, the tendency as a rule was to maintain the existing system with slight modifications. (Nehru, 1948)

With the shattered economy due to Second World War and the socio-political trauma due to the division of Indian subcontinent, we also inherited more or less the same educational problems, paradoxes and dilemma which various commissions and committees tried to tackle during the British period. There were pious platitude and inspiring recommendations which were not implemented for the one reason or the other. So that at the dawn of our independence we had a number of policy statements and visions of school science curriculum, yet we had to size up and tackle the problem of school education in general and science education in particular de novo.

Though India got political independence in August, 1947, the preparations for making use of science in a big way had already started. The Government of India etablished the All India Council for Technical Education (AICTE) in 1946 to advise on all aspects of improvement and a coordinated development of technical education. A Scientific Manpower Committee "to asses the requirments for various categories of scientific and technical personnel" was also appointed in 1947. Inspite of all that had been achieved under British rule, we began our freedom "on a fairly lower level of attainment in education in almost all respects." (Naik, 1975, Policy and Performance in Indian Education 1947-74. p. 2) We then had seventeen universities and six-hundred thirtysix colleges (with total enrolment of 238,000 students), 5279 secondary schools with 870,000 pupils (which implied that not even one youth in every twenty in the age group fourteen-seventeen was in school), 12,843 middle schools with two million pupils (which meant that only one child out of every eleven in the age group eleven-fourteen was enrolled) and 172,661 primary schools with fourteen million pupils (which implied that only one child out of every three in the age group six-eleven was in school). Educational inequalities were very large, especially between one region and another, between urban and rural areas, between men and women, and between the higher and intermediate castes on one hand and the Scheduled Castes and tribes on the other. The standards of education were generally unsatisfactory, especially at the school stage with too much of emphasis on literary subjects and "little stresson mathematics or science." Vocational and technical education was but poorly developed both at the school level and university stages and the supply of high level trained scientific manpower was limited. (Ibid., passim).

Educational Policy of Independent India

An insight into the educational Policy may be acquired from a statement made by Pandit Jawahar Lal Nehru (1948), the first Pime Minister of India, while addressing the All India Educational Conference of Education Ministers in 1948. He observed that "whenever confernces were called in past to form a plan for education in India, the tendency as a rule, was to maintain the existing system with slight modifications" and stressed that ,'this must not happen now." Pointing out to the fact that "great changes have taken place in the country and the educational system must be in keeping with them" he declared that, "the entire basis of education must be revolutionalized." (Nehru op. cit.,) Indeed the educational needs of independent India were different and ought to have been different from what they were under British India so as to be responsive to the needs of socio-economic amelioration of the masses. The national leadership had realized that what education needed was a revolutionary approach which alone could bring about radical changes in the objectives, structures, processes and organisation of education. The system of education, as it had developed by 1947, was narrowly academic in character and exclusively geared to the requirements of university entrance. In practice, even this narrow aim remained unachieved. For, only the few, who opted for university education, utilized the available facilities. For the large majority there was little opportunity to receive education. With the achievement of independence, there was a marked change in the aspirations of the masses. They came to look upon education with hopes of securing life chances. The Central and State Governments too, were conscious of those aspirations.

In June, 1947 the Committee on Curriculum of Basic Schools met under the Chairmanship of John Sargent. Dr. Zakir Hussain was one of the member of the committee. The Central Advisory Board of Education (CABE) in the first meeting after independence (1948) accepted Basic Education as the pattern for the elementary stage (I-VIII), and considered the interim report of the committee on curriculum of basic schools (Primary and Middle schools). The basic Curriculum Committee met again in October, 1949, under the Chairmanship of Prof. Humayun Kabir and finalisd the curriculum under the title "Syllabus for Basic Schools" (Ministry of Education (Bureau of Education). 1950.) This curriculum was envisaged as the curriculum for mass education.

School Science Education

Apart from Craft Work the 'new curriculum' (1950) consisted of Mother Tongue, Mathematics, Social Studies, General

Science, Art (including Drama, Music and Aesthetics, Games and Physical Activities, and Hindi. In contrast with the earlier recommendation of Dr. Zakir Hussain Committee, the Basic Curriculum Committee doubled the time alloted for science teaching which obviously indicated the importance it gave to science education at elementary school stage. There was also another significant departure from another view-point. In pursuance with the observations of the National Planning Committee (1938) that the syllabus prescribed by Wardha Scheme appeared to be rather ambitious for children below the age of fourteen and also in order to meet such criticisms which were made even by Basic Education workers, the content of General Science at the primary school level was reduced about 30 per cent in the 'new curriculum'. Whereas the Wardha Committee syllabus specified topics for grade I, II and III separately, the 'new curriculum,' lumped together and modified these topics in a new manner so as to allow for more flexibility needed to teach science in a manner envisaged by the Committeee. And by providing more time for the study of General Science, allowance was made for the realisation of the aims of science teaching. The revised 'syllabus for basic schools' (1950) circulated by Ministry of Education advocated three aims (1) utilitarian—ability to apply scientific knowledge in daily life and ability to understand physical environment in relation to one's position (2) disciplinary—ability to recognise the problem, to acquire a method of attacking problems, training in the abilities involved in problem solving and for making adjustment in the society, and (3) cultural. Highlighting the cultural aim the "syllabus for basic schools' (1950) advocated:

> Science teaching should have a cultural value of science which is now being recognised. In the past, science teaching was concerned with factual knowledge. Modern life recognises that the emergence of science as a body of tested laws and principles has been intimately bound with stories of romance, privation and adventure. This should become a portion of cultural background of every child. (Ministry of Education. 1950. p. 9)

Thus the above mentioned three aims of teaching science at elementary stage, were advocated and these were to be learnt by the child from handling a craft or interacting with his natural and social environment during his studies and through the teaching of 'General Science.' The prescribed content of General Science was based on topics borrowed from Physics, Chemistry and Biology according to Broad Field Curriculum Design of American Schools. The topics from these disciplines were not expected to be taught according to their hierarchy or sequence or order but for the purpose of exposition of physical, inorganic and organic objects and events encountered in daily life. It was for this reason that the preamble to the General Science syllabus emphasized that the topics in the science course were to be related to the experience of the child and to the Basic Craft. The teacher had to decide what particular topics he could include in his lesson on a particular occassion. (Ministry of Education. 1950. Syllabus for Basic Schools, p. 94)

The Hindustani Talimi Sangh (1952) in its Revised Syllabus for its Teacher Training listed a few principles governing the planning of curriculum of Basic Schools, through which the Sangh felt, that the scientific approach to the problems of daily life could be inculcated and the ideals of Nai Talim would be achieved. The Hindustani Talimi Sangh (1952) advocated that the programme of work in cleanliness and health in the preparation of food and care of sick in the upkeep of buildings and appliances and in the practice of the basic crafts, was filled with opportunities for the teaching of scientific principles, many of these were indicated in the relevant sections of the syllabus and every item of scientific information was to be introduced in this way, when the interest and need was apparent.

The Sangh further advocated that the purpose of the syllabus in General Science was to stimulate the spirit of enquiry, to form habits of accurate observation and accurate statement, and to give the pupils an intelligent understanding of the phenomena of nature and the inventions, and discoveries of man.

The Sangh further emphasized:

> In the higher grades the pupils should begin to understand what is meant by "a scientific attitude" to all problems of life, and its social and moral implications. General science should not however, be regarded as a separate "school subject". If scientific teaching is to fulfil its purpose it must be integrated with the activities and interests of daily life. (Revised Syllabus for Training of Teachers, passim. 4-21)

Thus the voluntary agency like Hindustani Talimi Sangh and the Governmental efforts were more or less in consonance with each other not only regarding the need of teaching science in schools but also the manner and purposes (utilitarian, disciplinary and cultural) for which it ought to be taught.

Not that efforts were not being made to implement the basic education system accepted in the First Five Year Plan of the country as the National Pattern of Elementary Education. While Central Government was making best efforts to implement the Basic System of Schools in India, each state was making efforts to introduce the National Pattern of Elementary Education. For instance, in pursuance of the recommendations of the Primary and Secondary Reorganisation Committee (1938-39) of Uttar Pradesh, popularly known as Narender Dev Committee recommended establishment of a complete, self sufficient, and integrated system of school education. Government of Uttar Pradesh, ten years later, established Government Central Pedagogical Institute at Allahabad in 1948, mainly for preparation of syllabuses for the educational institutions of the state and testing them in the Basic and Higher Secondary Schools, drawing up of criteria for textbook and providing actual help in their writing, preparation of handbooks for teachers on the methods and techniques of teaching: and conducting research in general educational problems. (The Government Central Pedagogical Institute, Allahabad, 1952. Its Scope and Functions, passim. 1-4)

The Government Central Pedagogical Institute, Allahabad made a survey of view-points of educational administrators regarding the curriculum for Primary Schools by sending a questionnaire to Heads of Government Normal Schools and the Inspecting staff to elicit their views on the matter. Seventy per cent preferred that the same curriculum be used for urban and rural schools and sixty per cent were of the opinion that the curriculum for boys and girls need to be different. The Institute also carried out an investigation to ascertain if the real significance of practical work in the scheme of science teaching was realized by it. The investigation revealed that demonstration experiments were used merely to illustrate a fact rather than to help students to find out what happened. Little attempt was made to adopt practical work in class room teaching as a means of training children in the use of the scientific method and in developing a scientific attitude in them. (The Government Central Pedagogical Institute, Allahabad, 1952. A Resume of Work Done, passim)

Thus the problem of uniform curriculum for rural and urban areas or for boys and girls was still under debate though a majority favoured a same curriculum, for both type of schools. The science-teaching at school stage was also not satisfactory as the investigation revealed. Whatever good was visualized through statements of aims and objectives of teaching science in curriculum, when implemented by the users in day-to-day classroom teaching there appeared shifts in emphasis. All those ideas could not be put into practice. The traditional ways and methods of teaching science were continued by virtue of the inertia of the school system itself for obvious reasons. As there was no study available which could reveal the position of science teaching at national level during the period under review, the findings of the Government Central Pedagogical Institute, Allahabad, might be taken as an example of the position of science teaching in the country.

The University Education Commission (1948-49)

In 1948, Government of India appointed the University

Education Commission, popularly known as Radha Krishnan Commission. It had necessarily, to take into account the school curriculum as well. While advocating the main aims of formal courses of study, the commission held that general education ought to be the 'first aim'. General education according to it could "make available to the student and to inspire him to master, wisely selected information," so that he would have "representative and useful data on which to base his thought, judgement and action," and as a part of general education for living, "every step of education from primary school to the completion of undergraduate university work should include teaching of science". (The University Education Commission. 1948-49. pp. 124-125)

According to the Commission the place of science was to help the student to understand and to use the scientific method and to have an active and intelligent interest in the whole of the physical and biological world. This notion was, by and large, in consonance with the notion of general science advocated in the 'syllabus for basic schools' discussed earlier. But the Commission visualized different kind of science courses for non-science and science students. For non-science students, the aim of science teaching was 'not to make the student a qualified scientist in each field,' but to give him 'such introductions to each that his general reading and experience in that field' would be facilitated. While indicating some working principles for such school science curriculum, the Commission advocated that in each of the major fields of science the student was to be acquainted with the major concepts and with typical cases or illustrations which would make the concepts real to him. For students making science their chief field, the Commission recommended the inclusion of "more detailed, more rigorous, more in the nature of a foundation for later specialization in that field." (Ibid., p. 124)

It appears, as if the elitist-educationists seeped in the liberal (literary) traditions—The Structure of the Discipline Movement—predisposed to view the need for imparting 'systematized knowledge' for the cultivation of human talent (scientific manpower) (with an eye on modernization (industrialization) of India, valued 'concept-approach' to teaching of science. On the other hand, the 'constructive programme' workers as well as some educationists seeped in the values of National Struggle for Independence—the values of 'Sarvodaya' predisposed to ameliorating the conditions of masses with an eye on village uplift and better style of life, so that the people might be liberated from the age old superstitions, traditional uneconomic modes of production and hierarchical caste structures etc., in consonance with the Progressive Education Movement, valued teaching of science—'general science' on the pattern of Broad Field Curriculum Design of America.

It is difficult to infer how far educationists in both camps were influenced by the theoretical positions regarding teaching of science by educational theorists, curriculum planners, methodology's specialists in American and European countries. But it can be presumed that the 'debates' about teaching approaches in general and teaching of science in particular, found an echo in our country as well. For example Kher (1951), while inaugurating the 26th conference of the All India Federation of Educational Associations advocated that independent India was to work out and evolve her own national system with roots in her soil and ancient culture, to express her aspirations, ideals and to contribute to the all round material and moral progress of the country, and through it to the world. Further, he directed that imitation of foreign ideas would not work and had built up our national system of education with our own hard labour and love with faith and understanding. (Conference Report, p. 21) Perhaps, he was not just addressing the gathering but, involved as he was with the attempts at educational reconstruction, he appeared to be concerned about the suggestability of our educational policy planners and administrators. Be that as it may, at the end of the period under review, an opportunity itself came to build up our National System of Education while formulating the First Five Years Plan for national development.

First Five Year Plan

In March 1950, the Government of India resolved that planning in India was intended to promote a rapid rise in the standard of living of the people by exploitation of the resources of the country, by increasing production, and offering opportunities to all for employment in the service of the community. The First Five Year Plan held:

> The Central objective of planning in India is to raise the standard of living of the people and to open to them opportunities for a richer and more varied life. Planning must, therefore, aim both at utilising more effectively the resources, human and material, available to the community so as to obtain from them a larger output of goods and services, and also at reducing inequalities of income, wealth and opportunity. . . . Our programme must, therefore, be two-fold, leading at once to increase productivity and reduction of inequalities. . . . While in the initial stages the accent of endeavour must be on increased production because without this, no advance is possible at all. Our planning even in the initial stages should not be confined to stimulating economic activity within the existing social and economic frame-work. That framwork itself has to be remoulded so as to secure progressively for all members of the community full employment, education, security against sickness and other disabilities and adequate income. (Ministry of Information and Broadcasting. 1953. p. 11)

Taking note of the fact that considerable industrial development and urbanisation had already taken place, the First Plan highlighted the fact that mainstay of life for about seventy percent of the people in agriculture with a exceedingly low level of productivity concerned with raising the productivity. The plan observed that "In an under-developed country quite small investments in capital equipment may be able to produce quick and significant increase of output. Taking a clue from Japan, where between 1890 and 1920 agricultural production was increased by seventy-seven per cent mainly through better seeds, manure and insecticides and improved agricultural practices, none of which involved large outlays. (Ibid., p. 13) The First

Plan therefore, with its emphasis on agriculture, made considerable provision for investment of this character. However, the plan visualised that in additions to investment that were required some additional resources could be secured by more intensive utilisation of manpower, land and existing equipment. It presumed that, idle manpower could be used for works such as digging canals, repairing tanks, agricultural work, universalising of elementary education.

To presume that idle manpower can be used or that community effort would be available. Over and above, the financial provisions to achieve the constitutional obligation expressed a pervasive motivation—perhaps arising out of socio-political commitments as well as hesitancies in evolving a realisable policy—perhaps due to paucity of resources. But much of it later.

The planners were aware that the emphasis on increasing production would restrict the expansion of social services but it was obvious to them that "planning can not succeed unless investment in the improvement of human material are made." (Ibid., p. 14) According to the plan "even from the point of increasing production social services like education, technical training and health can bring significant returns." (Ibid., p. 14) However, it visualized a large scope in this field for direct community effort, and therefore, expected that much can be accomplished "over and above for which financial provision is made." (Ibid., p. 21)

The plan found the existing educational facilities obviously inadequate. It noted that provision was available for forty percent of the children in the age-group six-eleven, ten percent in the age group eleven--seventeen, and 0.9 per cent in the age group seventeen-twentythree, while free and compulsory education for all children upto the age of fourteen, within ten years of commencement of the constitution, i.e., by 1960, was one of the constitutional obligations.

The planners were also aware of the fact that the educational system suffered from various defects. Apart from being top heavy, the plan observed that an undue emphasis on academic training had retarded the development of a practical sense and resourcefulness among many students, and the absence of adequate facilities for technical and vocational education resulted in a much larger number of them going in for general education than was justified by the requirements of the country or their own aptitudes. It noted that in order to suit the country's need, some attempts were made to remodel the system by accepting the basic pattern, opening of new basic schools, converting some of primary schools in basic ones and making the secondary education more broadbased and practical. But, according to the planners, by and large, teaching continued on the old line and practically entire task of remodelling the system still remained to be done. (Ibid., p. 220)

However, the agencies through which the remodelling of the system could be initiated were the Central Government, State Government, Local bodies and private agencies. The plan noted that according to the Constitution, education was mainly the concern of the states and, therefore, for the school education the Centre could do a little except to help the backward States. The plan suggested that the Centre "should concentrate on helping, on a contributory basis, those States which are willing to cooperate in the activities which have an all India significance, such as, research on techniques, training of selected personnel, production of literature, the conducting of pilot experiments, etc." (Ibid, p. 222)

The planners thought ". . . necessary to have expert body at the Centre to guide and coordinate basic, social and secondary education in the State". (Ibid, p. 222) Regarding primary including basic education, the planner noted, that for children in age-group six to fourteen, basic education was accepted the pattern of education and observed that the foremost task in this field was the improvement of technique and the development of methods by which it could be passed on to the vast majority of teachers of rather low educational qualifications (Ibid, p. 222)

The plan suggested opening of atleast one group of model basic institutions in each Part A and Part B States as well as in Delhi amongst Part C States. According to the planners each group was to have a number of basic and pre-basic schools, a post-basic school, a teacher's training school and a teacher's training college. Regarding secondary education the planners did not consider it proper to anticipate the recommendations of the Secondary Education Commission which was appointed in September, 1952 but they expressed the desire for secondary education to grow from the education which was being given at the mass level. In other words, it was to be closely integrated with basic education and the child was not to feel that in passing from a basic school to secondry school there was a violent break in the curriculum and methods of teachings. (Ibid, p. 253)

In view of the proposed expansion of school education, a large number of teachers were to be required within a short period of time. The planners considered it a 'colossal task' and underlined the need of closest cooperation among the Centre, the States and non-official bodies. They suggested that besides the services of experts in basic education the programme required help from allied departments such as, those of agriculture, animal husbandary, social service, etc.

However, regarding the role of Central Government it was observed that it could accept only a limited obligation in the field of education. Considering lack of the financial resources, the Central Government was not in a position to accept any large measure of responsibility for basic education. Therefore, the approach of the Central Government was selective. Accordingly it assisted pilot projects, experiments in improved educational methods in different educational fields and so was the case with the school science. (Ibid, passim)

Review

During the period 1947-52, the system of basic education was the accepted national system of education. Accordingly, the syllabus for basic schools was prepared which was by and large meant for mass education. The syllabus for basic school visualized the general science approach to teach science at elementary stage in an integrated way with the activities and interests of daily life and not as a separate school subject. The general science approach was based on the Broad Fields Curriculum Design. Besides this view, another view was to teach science as systematized knowledge-concept approach. Thus there were two views regarding teaching of science—one general science approach and another concept approach. Moreover, the debate for having same science curriculum for rural and urban schools also continued. Thus there was no clearcut policy for science teaching at school stage. It appears that our leadership was aware of the imitation of these foreign ideas being adopted without proper educational experimentation. They wanted to build up the national system of education with their own hard labour and love and to achieve with faith and understanding a revolution in the system of education.

The teaching of science was not satisfactory. Whatever was proposed to achieve through the the statements of aims and objectives and approaches, could not be put to practice and the traditional method of teaching science continued. Amongst many obvious reasons, one was the inbuilt inertia of the educational system.

Selective approach and that too stage by stage was the policy of Government of India for improvement in the area of school science. The Government efforts appeared to be geared towards the general science approach of teaching science. The education itself was perceived under the heading 'Social Services' and was clubbed with health training etc. Though the role of education vis-a-vis, national prosperity was recognised but inspite of this, in the planning process, education got relatively less emphasis. The Central Government could not but accept a limited obligation in the field of education due to higher priorities given to agriculture, irrigation and allied facilities. With education getting a secondary place, the school science education was an area which got very little attention.

REFERENCES

Central Advisory Board of Education (CABE). 1948. *The Proceedings of the Meeting*. New Delhi: Ministry of Education (Government of India).

CABE. 1952, *The Proceedings of the Meeting*. New Delhi: Ministry of Education (Government of India).

Government-Central Pedagogical Institute. Allahabad, 1952. *A Resume of Work Done*. Allahabad: Superintendent Printing and Stationary Government of Uttar Pradesh.

Government—Central Pedagogical Institute Allahabad, 1952, *It's Scope and Functions*. Allahabad: Superintendent Printing and Stationary. Government of Uttar Pradesh.

Government of India, 1953. *First Five Year Plan*. New Delhi: Ministry of Information & Broadcasting. (Government of India).

Hindustani Talimi Sangh. 1952, *Revised Syllabus for the Training Teachers* (*Basic National Education*), Sevagram Wardha, (M.P.): The Hindustani Talimi Sangh.

Kher, B. G. 1951, Inaugural Address, *Report of the XXVI Conference*. Bombay: All India Federation of Educational Associations.

Ministry of Education (Basic Curriculum Committee). 1950. *Syllabus for Basic Schools*. New Delhi (Ministry of Education) Government of India.

Naik, J. P. 1975, *Policy and Performances in Indian Education*. New Delhi (Jamia Nagar): Dr. K. G. Saiyidain Memorial Trust.

Nehru, Jawaharlal, 1948, in (*CABE. 1948*).

University Education Commission (1948-49). *The Report of the University Education Commission* (*Volume I*). New Delhi: Ministry of Education (Government of India 1962 Edition—Reprint NCERT).

Basu, R. K., 1952, Position of Elementary Science in Present Curriculum of Indian Schools in *Short Reports of Studies in Education and Psychology by M. Ed. Student of CI E.* (*1950*) Delhi Central Institue of Education.

Bihar Basic Education Board, 1951, *Basic Education in Bihar* (*Edited by R. S. Upadhyaya*). Patna: Cultural and Social Development.

Board of High School Education Central Provinces and Berar, 1948, *Reorganisation of Secondary Education*. Nagpur: Government of Printing C. P. and Berar.

CABE. *The Proceedings of the Meeting of the CABE. January, 1949, January, 1959, April, 1950. January 1951.* New Delhi: Ministry of Education (Government of India).

Government of India, 1952, *First Five Year Plan*: New Delhi: Ministry of Information and Broadcasting (Government of India).

Government of India, 1953, *Our Plan*, Ministry of Information and Broadcasting. Publication Division (Government of India).

Ministry of Education, 1954, *Progress of Education in India, 1947-1952, Quinquennial Review.* New Delhi: Ministry of Education (Government of India).

Ministry of Education, *Education in India, 1947-48 1949-50, 1950-51* (*Volume I*) *Annual Reports.* New Delhi: Ministry of Education.

National Council of Educational Research and Training NCERT, 1961. *Review of Education in India (1947-1961)—Ministry of Education.* New Delhi: NCERT.

NCERT 1961, *Review of Education in India* (*1947-1961*) *Ministry of Scientific Research and Cultural Affairs.* New Delhi: NCERT.

Planning Commission, 1951, *The First Five Year Plan—Draft Outline*, New Delhi: Planning Commission Government of India.

Planning Commission, 1952, *The First Five Year Plan.* New Delhi: Planning Commission (Government of India).

Planning Commission. 1954, *Summary of Recommendations—The first Five Year Plan.* New Delhi: Planning Commission (Government of India).

Prasad, K. N. 1980, *Problem of Economic Development in the Third World with Special Reference to India.* New Delhi: Sterling Publications Pvt. Ltd.

6

SCHOOL SCIENCE EDUCATION DURING 1952-57

> "The middle school is not the place for specialization. . . It is desirable to formulate general science courses for the middle stage." (Secondary Education Commission, 1952-53, p. 67)

If the period 1947-52 was a period, of acceptance of Basic Education pattern for the elementary (Primary and Middle) school stage (CABE, 1948), of revisualisation and acceptance of blue print for university education (University Education Commission, 1949) and of laying down mechanism for Centre and the implementation of decisions taken for consolidation and State cooperation in reconstruction of educational system to meet the country's need for economic development (First Five Year Plan), the period 1952-57 started with a national level effort to look at the 'Weakest Link' in the system of education in India—the secondary education system. Even though the secondary education was a state subject, yet the constitutional responsibility of maintaining standards in higher education and technical education being that of Central Government, it was argued that these cannot be maintained or improved because secondary education was decisive in determining the standards of education at higher stages of education. Again, secondary education not only provided the clientele for university and other higher institutions or supply of teachers for primary schools responsible for the quality and standard of education provided to coming generations, but also created an educated class which provided leadership to local communities and performed the role of 'Intermediate Leadership'. Because the secondary education prepared our citizens for various directions, it was percieved as being 'essential to sound economic development'.

Secondary Education Commission (1952-53)

While piece-meal reforms were proposed and introduced from time to time, the problems of secondary education as a whole were not considered in a comprehensive manner. So the Government of India, taking into account the CABE (1948)'s recommendations and CABE (1951)'s reiteration of its earlier recommendations, appointed the Secondary Education Commission in September, 1952 under the Chairmanship of Dr. A.L. Mudaliar to report on the existing position of secondary education and suggest measures for its reorganisation and improvement with particular reference to its aims, organisation, content and relationship with other levels of education. (Report, p. 2) Apart from Indian educationists, the Secondary Education Commission had Principal John Christie from Oxford (U. K.) and Dr. Kenneth Rast Williams from U.S.A. The Commission also coopted some other educationists from the states of India. Through questionnaire, interviews, and meetings while touring the states, the Commission processed a mass of data on the status of secondary education and submitted its observations and recommendations in its report in September, 1953 which was approved by CABE in 1954.

The Commission set out the aims of secondary education in the light of the task of building 'a secular democratic republic', which according to it meant that " . . . the educational system must make its contribution to the development of habits, attitudes and qualities of character, which will enable its citizens to bear worthily the responsibilities of democratic citizenship and to counteract all these fissiparous tendencies which hinder the emergence of a broad, national and secular outlook." (Ibid., p. 19) Noting that inspite of having rich potential resources, our country still being a poor country where a large majority of people were living an economically subhuman level, it observed that our most urgent problem was to improve productive effeciency, to increase the national wealth and thereby to raise appreciably the standard of living of the people." (Ibid., p. 19) The Commission further observed that:

> partly as a result of this oppressive and widespread poverty there is a serious lack of educational facilities and the bulk of the people are so obsessed with the problem of making some sort of a living that have not been able to give sufficient attention to cultural pursuits and activities. Hence, there is need for orienting the educational system in such a way that it will stimulate a cultural renaissance. (Ibid., p. 19)

With these basic concepts, the Commission identified the aims of secondary education to be: to fit the students to participate creatively as citizens in the emerging democratic social order, the improvement of their practical and vocational efficiency so that they may play their part in building up the economic prosperity of their country, and to develop their literary, artistic and cultural interests. While delineating the role of education in developing democratic citizenship, and noting the fact that citizenship involves many intellectual, social and moral qualities, which cannot be expected to grow at their own accord, the Commission stated that "to be effective, a democratic citizen should have the understanding and intellectual integrity to shift truth from falsehood, facts from propaganda and to reject the dangerous appeal of fanaticism and prejudice. He must develop a scientific attitude of mind to think objectively and base his conclusions on tested data." (Ibid., p. 20) Accordingly, the Commission considered that "an understanding and appreciation of the fundamental principles of the natural and physical sciences is essential to effective living in the world of today." (Ibid., p. 77)

While reviewing the existing curricula in secondary schools, the Commission noted that "owing to the great influence that the college curriculum exercised over the secondary school curriculum the latter became unduly bookish and theoretical. (Ibid., p. 62) The Commission thought that it is neither possible nor desirable to teach children all the facts, even the most important of them, that they are likely to need in later life." (Ibid., p. 63) The Commission, therefore, suggested that it was "more important to awaken interest and curiosity in the child's mind to teach him the methods and technique of acquiring knowledge than to burden his memory with miscellaneous information." (Ibid., p. 64) and that "in organizing our curricula and selecting methods of teaching, we must not lose sight of these crucial principles" (Ibid, p. 65)

Indeed, while suggesting the basic principles of curriculum construction, the Commission stated that "it must be clearly understood that. . . . curriculum . . . does not mean only the academic subjects traditionally taught in the school, but it includes the totality of experiences that pupil receives through the manifold activities that go on in the school, in the classroom, library, laboratory, workshop, playgrounds and in the numerous informal contacts between teachers and pupils." (Ibid., p. 65) So while formulating the curriculum at the middle stage, the Commission stated that:

> The function of the middle school curriculum is to introduce the pupil in a general way to certain broad fields of human knowledge and interest. We would like to underline the phrase 'in a general way.' The middle school is not the place for specialisation, but the stage when a general introduction to all the broad and significant fields of knowledge can and should be given. The phrase 'in general way' indicates the scope of the course; it is not the depth of knowledge in any particular field but familiarity with the different important fields in which human mind has been active throughout the ages and out of which the pattern of human culture has been evolved. The purpose therefore is twofold;

> the child as the inheritor of the treasures of human civilization has the right, firstly, to know what its main components are, and secondly, as a result of acquiring that knowledge to choose at a later stage, the particular field in which he can in his own way contribute his share to this fund of human culture. (Ibid., pp. 67-68)

Presuming that the special abilities and interests of the majority of the people would be taking definite form by the end of the middle school stage, the Commission thought that the curriculum at the High/Higher Secondary stage ought to be diversified. The Commission observed that:

> For the large majority of these adolescents this will be all the education that they will receive. In a normally functioning educational system not more than twenty-five to thirty per cent of the pupils in High Schools are likely to go to the universities and other institutions of the higher learning such as, technological and similar institutions. So most of them have to think of learning a living and the educational programme should give them some training in this direction—not so much in terms of specific vocations as in training their practical aptitudes in the preparation for definite vocational work later. (Ibid., p. 69)

The Commission recommended certain core subjects common to all and certain optional subjects for the higher secondary course. Noting the difference in the period of secondary education—three years in the one case and four years in the other, the Commission conceived two levels of integration of the subject matter with the core subjects as well as optional subjects. According to the Commission, the need for developing an integrated course was so great that " . . . instead of allowing pupils to choose from a very wide range of options according to their individual inclination as is done in certain countries and even in some states of India, the Commission, preferred to group subjects under certain broad headings in order to allow for some amount of integration and cerrelation." (Ibid., p. 70)

The Secondary Education Commission gave broad outline of the curriculum at the High School and Higher Secondary stage which according to it was "intended to be only suggestive." (Ibid., p. 71) The State Departments of Education were given the responsibilities "to work out the details and fill the outline after making a careful study and investigation of the problem." (Ibid., p. 71) The curriculum suggested by the Secondary Education Commission consisted of compulsory core subjects amongst which, apart from Mother Tongue or Regional Language or a composite course of the Mother Tongue and a classical language, one other language, and one craft, general courses of Social Studies and General Science including Mathematics were prescribed for the first two years. Seven groups of optional subjects, from each of which three subjects had to be offered, were suggested. Amongst these, group two 'Science' had (a) Physics, (b) Chemistry, (c) Biology (d) Geography (e) Mathematics and (f) Elements of Physiology and Hygiene (not to be taken with Biology). (Ibid., p. 72) The courses of Social Studies and General Science were to be provided for those who would not take up these or allied subjects among their optionals. According to the Secondary Education Commission:

> A pupil taking up either History or Geography or elements of Economics and Civics, in the 'Humanities' group will be required in the second year when differentiated courses begin to take up the course in general science and not in social studies. Similarly, a pupil taking the sciences, under the 'Science' or 'Technical' or 'Agricultural' group should take the course in social studies, but not in general science. Students who take the commercial group will be studying some phases of social studies as a part of their course in commercial geography or elements of economics and civics. In that case they will be exempted from taking the Social Studies course in General Science. For students taking the 'Fine Arts' group some knowledge related to Social Studies may be covered in the course on the history of art. So they take the course in general science, but not ordinarily in social studies. The Home Science' group should, we feel,

take both Social Studies and General for the first two years. (Ibid, p. 73)

General Science Curricular Trend

While discussing the purpose of teaching general Science the Secondary Education Commission considered that "both from the point of view of students adjustment to their natural environment and of providing the proper background for the more specialized studies later, it is desirable to formulate General Science courses for the middle stage." (Ibid, p. 77) But at the High School stage the Commission thought that "there will be a specialised reorientation of the science courses and Physics, Chemistry and Biology wll be taught as independent subjects." (Ibid, p. 77) Being aware of the fact that teaching of independent subjects tends to be 'unduly bookish and theortical', the Commission was quick to point out that:

> It is to be noted that the Science syllabus in the Secondary School is not directed to the "production of scientists." It's aim is to give basic understanding and appreciation of scientific phenomena—biological and physical, which may prepare the non-scientists for a fuller and more complete life.

Yet feeling the need to articulate secondary school curriculum with that of higher education, the Commission suggested that "at the same time, the courses should give fundamental principles to those relatively few who will later specialize in science." (Ibid, p, 77)

Thus it is not very clear whether the Commission wanted science courses to provide basic understanding of scientific phenomena to 'non-scientists' for a fuller and more complete life or the courses should give fundamental courses to those who will specialize in science later. Taken with its recommendation to give responsibility to work out details and to fill the outlines to State Departments of Education, the Commission's suggestion regarding the curriculum at higher stage was a suggestion amenable to different if not contradictory interpretations. But much of it later.

The Commission, it appears was also not very clear in its policy so far the science teaching at school stage was concerned. There were no clear cut directions for executors and implementers of the policy. On the hand, it desired 'an understanding and appreciation of the fundamental principles essential to effective living,' and on the other hand, emphasizing' both from the point of view of students adjustment to their natural environment and providing the proper background for the more specialised studies later, it desired 'general science courses for middle stage'.

American Influence in School Science Education

Out of nine members including Chairman, two were foreign members of the Commission. These foreign members played an important role. As pointed out by Sharma (1979) "Dr. Kenneth Rast Williams U.S.A. was associated in the formulation of the recommendations of the Secondary Education Commission." (American influence in Indian Education, p. 113) He observed that "inclusion of Social Studies, General Science, Agricultural Group, Fine Arts and Home Science can also be attributed to American influence." (Ibid., p. 120) Perhaps, this may be so because, we were a newly created democratic country and our constitution makers while framing the Indian constitution, not only needed to learn from the experience of other democratic countries for building institutional patterns in our body-politic but also tended to be positively oriented towards other patterns of social action in other fields too—such as education. Some of them appeared to be predisposed to view emergent educational needs in India according to the normative patterns of education in western democracies. While discussing the processes of controls and decision making in educational systems Shukla (1967) observed that "during the fifties, there was a general climate of receptivity to American educational ideas, as (a) these were seen to be a proper liberating influences as compared with our previously supposed British educational heritage (b) the view was prevalent that American education was democratic education par excellence, and, therefore, our only suitable model and (c) prospects were visualized of American financial assistance—sizeable by the modest standards of educational leaders in the country." (Controls and decision making in the educational systems, p. 300)

Thus it appears that General Science in school curriculum claimed a fairly prominent place perhaps due to the initiative of those who were influenced by the American educational ideas. As observed by Shukla:

> The teaching of integrated every day science in the form of explanation of day to day phenomena and related activities as against the academic teaching of separate subjects e.g., Physics, Chemistry, Biology is not entirely a new idea even in the prevalent Indian School System. It emerged on the Indian Educational Science in a big way in the early 1950s largely as a result of the American education influence. (Ibid., pp. 299-300)

School Science in America in Historic Perspective

To reflect upon the American influence on our school science system, it would be worthwhile to study the school science system of America. As pointed by Bingham, while discussing 'The Current Revolution in Science Teaching in America', "General Science and General Biology were introduced into the American schools in place of specific disciplines, in an effort to make all students aware of the nature and extent of science, and to give them experience in working the way a scientist works." (Bingham, N. E. 1963. p. 1)

The subject-centred curricula was the oldest prevailing form of organizing a curriculum. It followed, ". . . a logic of the pertinent discipline that is, both the content and the learning experiences related to acquiring it are divided and organized by the logic of the respective subject areas," as pointed by Taba

(1962), was the assumption (Fundamentals of Curriculum Development, p. 383)

The chief defence of the subject organization was that "subjects constitute a logical and effective method of organizing new knowledge and therefore an effective method of learning it. By following organised bodies of subject matter, a student can build his store of knowledge more effectively and economically. Having such a stock of knowledge available makes it possible for individuals to use it when needed." (Ibid, p. 386)

The questioning of the 'logical' order of learning started first as a rebellion against sterile knowledge that the subjects represented in the 1920s, but it spread to a rejection of any type of organized content. This rebellion or organization of dissent, as pointed out by Cremin (1961) was "based at first on the semi-intutive concern for individual development, for independent thinking, creativity, freedom and the right of childhood to learn actively and to formulate its own thought and ideas instead of merely absorbing the social heritage—the late form of the progressive movement of the 1920's and 1930's." (Ibid., p. 387)

The criticism of the conventional subject curriculum gave rise to the 'activity or experience curriculum.' The activity curriculum was "planned specifically to counteract the passivity and sterility of learning and the isolation from the needs and interests of children of the conventional curriculum. It was widely used at the elementary level." (Ibid., p. 400) The rationale of the approach was that "people learn only what they experience. Only that learning which is related to active purposes and is rooted in experience translates itself into behaviour changes. Children learn best those things attached to solving actual problems, that help them in meeting real needs or that help them with some active interest." (Ibid., p. 401)

Out of the criticisms of the subject centred design of curriculum, another design of curriculum-Broad Fields Curriculum emerged. The Broad Fields Curriculum was "essentially an effort to overcome the compartmentalization and atomization of curriculum by combining several specific areas into larger fields. History, Geography and Civics were combined into social studies. The first courses in General Science were composed of special sections of Chemistry, Physics, Zoology, Astronomy and Geology. (Ibid., p. 393)

While the Broad Fields Curriculum was supposed to disregard the logical fences that specialists had for convenience erected between their subjects,, the hope for integration and unification of knowledge did not immediately materialize. In many instances, the areas were broad in name only, because the reorganization was only formal and the experimentation with reorganizing the content to make it appropriate for integration was quite superficical. (Ibid, p. 393) Some of the topics of Broad Fields Curriculum were thought of as, the Patterns of Life, The Origin of Life, Matter and Energy, Introduction to Photosynthesis, Mechanism of Photosynthesis, Protecting Life and Health, Getting a Living, Making a Home, Dealing with Plant, Animal and Insect Life, The Atmosphere, Problems of Transport and Communication, Understand Ourselves, The Universe We Live in, Health to You, Science and People etc. Similar courses or topics were prescribed in the syllabi of General Science for elementary and secondary schools. The Basic Schools Curriculum and subsequently syllabi formulated according to the recommendations of Secondary Education Commission have had much in common with the topics of the Broad Fields Curriculum. (Appendices A and B).

In fifties the Americans were again wanting revolution in school science teaching. There was "an emphasis on content, disciplined knowledge and the lifting of the intellectual level by a return to compartmentalized subject." (Ibid, p. 392)—Structure of a Discipline Movement. Moreover, the upsurge in Science Education in the world accelerated the pace of revolution in science teaching and that revolution gave rise to different School Science Programmes in America. These American Science Programmes influenced the school science programmes in our country. But much of it later.

All India Council for Secondary Education

Following the recommendations of the Secondary Education Commission, the Government of India set up the All India Council for Secondary Education (AICSE) to tackle the organisational and administrative problems involved in the reform of Secondary Education in 1955. (Governmentof India, 1955) The AICSE functioned as an autonomous body under the general supervision of the Ministry of Education. The AICSE was constituted both as an advisory and an executive body. The executive arm of the Council was its Advisory Field Staff constituted of a Director, a Deputy Director and Field Advisers. A team of Technical Cooperation Mission (T.C.M.) experts was attached to the Council to give it expert guidance and advice in developing multipurpose schools especially in respect of the practical streams. (AICSE, p. 67)

In the implementation of these programmes, the Ministry of Education and the Council received generous assistance from the Ford Foundation and the T.C.M. (Ibid, p. 67) As pointed out by Suhkla (1967), the Council itself developed much of its activity out of Ford Foundation finance for pilot projects connected with the implementation of the report of the Secondary Education Commission. (Shukla, op. cit., p. 300)

Not only the funds for the activities, the activities of the Council were influenced by the American knowhow and expertise. The Council undertook a number of projects and programmes. An important project—Extension Services Project was taken up in the year 1955-56 under which extension services centres were established in twenty-four post-graduate training colleges, the object being to provide in service training to teachers through the organisation of seminar, workshops, conferences, discussion groups, education exhibitions etc. Thirty Research Projects were taken up in twentyone Teachers' Training Institutes with a view to improving teaching in training colleges and promoting research. Another programme was organisation of seminars of headmasters of secondary schools, inspecting officers, teachers in training colleges, officers of Directorates, etc., for the discussion of common problems of objectives and methodology.

Another significant long range programme taken up by the AICSE was examination reform. It was drawn up with the help of Dr. B. S. Bloom of the University of Chicago who conducted various workshops in examination reform. Trained persons under these programmes were appointed as Evaluation Officers and Field Advisors both in the Examination Reform Unit under AICSE as well as in the Units of the Education Directorates of the States.

The AICSE undertook another project—'strengthening of Science Teaching in Secondary Schools' under which the science clubs were sponsored in about three hundred and fifty schools and training colleges. A Central Science Club and Workshop was set up in Delhi. A number of Science Club Sponsors' Conference were held. Experimentation in Schools, to encourage school teachers to undertake such experiments as might promote improvement in class room instruction and school organisation was also initiated. Study of special problems through various methods were taken up. Though a programme for assisting three hundred existing schools with better facilities for the teaching of science was approved by the Ministry, the programme for improving the teaching of science were taken up only in two hundred and fourteen schools during the First Plan Period. (Joshi, 1965. p. 2)

To advise the Council on steps to be taken to improve the Science Teaching in secondary schools the Council authorized the Chairman to appoint a Committee of five persons. The Committee laid down the criteria (AICSE, 1956) for financial assistance to science clubs, by recommending that "the grants should not be utilized for payment of remuneration to the sponsors of science clubs but should be utilized only for purchase of equipment and promotion of activities." (AICSE, 1957)

First National Seminar on the Teaching of Science in Secondary Schools (Taradevi Seminar)

Following the recommendations of Secondary Education Commission, the Ministry of Education, apart from providing assistance for converting primary schools to Basic Education pattern approved "assistance to three hundred schools for improving existing facilities for teaching science." (Ministry of Education, 1956) The Secondary Education Commission as discussed earlier had also recommended the teaching of General Science as a non-examination compulsory subject to all high school students. But the Commission did not pay any attention as to how this was to be done. To explore ways to implement it ond other recommendations of Commission, the Government of India appointed a Central Co-ordination Committee which, with the help of a number of subcommittees, working over a period of several months produced a set of suggestive syllabi, both in the core subjects and in the subjects under the diversified groups, that were recommended by the Secondary Education Commission. A five member Committee under the Chairmanship of Dr. A.C. Joshi prepared the draft syllabi for science subjects for the higher secondary schools. (AICSE, 1956) These syllabuses were communicated to the states for adoption after taking into account the needs of the age-group—fourteen to seventeen years and the expected standard being as near as possible to the standard of the existing Intermediate examination. While preparing the syllabuses the members of the Coordination Committee felt the shortage of time at their disposal as well as the inadequacy of the experience in the several fields. So to do the justice to the subject they thought of to get these syllabi be examined and reviewed by a large body of teachers associated with the teaching of Science in secondary schools. It was felt that once these teachers—lecturers of training colleges, get a clear conception of the nature and scope of syllabi and the methods of teaching, then, through the in-service programmes of extension service centres as well as through the regular training courses they would be able to assist in revitalising the teaching of Science in Higher Secondary Schools and bring about the necessary reorientation in the outlook and competence of science teachers.

Thus a seminar on the Teaching of Science in Secondary Schools, popularly known as Taradevi Seminar, was organised by AICSE from June 15-30, 1956 at Taradevi, Simla Hills. According to one of its participants, it was convened "either at the initiation of or with the assistance of a UNESCO Science specialist in India", (Shukla, op. cit., p. 300) Though the major objective of the seminar was to review the draft syllabi in science subjects for higher secondary classes, the seminar examined the syllabi for Elementary Science (primary and middle school level) as well, because it was "the foundation and complex of General Science at the Secondary level." (Report of the Taradevi Seminar, p. 2) Forty-six lecturers of training colleges associated with science teaching from sixteen states of the country participated. Besides Indian Participation, the foreign experts too participated in the seminar. Prominent among which were, Dr. C.F. Ward of Ford Foundation, Dr. C.S. Liddle of T.C.M., Mr. Bruton of British Council, Dr. Gorden Machenzie, Dr. George Hampson of Canadian High Commission.

The tone of the seminar was set by the introductory remarks of Dr. A.C. Joshi, Director of the Seminar, who said:

> The purpose of science education cannot be only to train expert scientists. They are necessary for any modern nation, but it is equally necessary that the ordinary people should know what science is and how it tries to do things. For this a knowledge of scientific facts and principles is not as important as an understanding of the scientific way of doing things. Such a broad perspective can be provided only by a sound course of science in schools. If this is done, then not only will a few receive training that will fit them for a scientific job later on, but many will also get an intelligent grasp of science and its significance in the present-day social and economic life. (Ibid, p. 22)

Thus emphasizing the need of teaching of process of science instead of its products, i.e., scientific facts and principles, Dr.

A.C. Joshi reiterated the same concept while touching upon the formulation of curriculum. He argued that:

> While formulating a curriculum of science for the schools it has to be remembered that its purpose is not to encourage any slavish study of a stereo-type course, however, excellent it may be . .. The choice of the subjects has to be adjusted to local conditions such as the aptitude of the children, the environment and resources of the school and the particular interests and ability of the teacher, for it is really on them that the vitality of the course and its ultimate sucess will largely depend (Ibid, p. 23)

The general programme of the seminar was regulated by a steering committee. A detailed study of the various problems was made through seven working groups on (i) Science in Elementary Schools, (ii) Science in Higher Secondary Schools (iii) Instruments and Equipments, (iv) Laboratory Organisation, Teaching Aids, Textbooks and Science Clubs, (v) Examinations, (vi) Teacher Training, and (vii) General Science Syllabus.

The Seminar made recommendations on each of these areas. Some areas are of special interest and relevance from the viewpoint of the present investigation.

Science in Elementary Schools

The seminar visualised the aims and objectives of science teaching at the primary stage as: arousing and maintaining interest in Nature and in the physical and social environment; arousing love for nature and the habit of conserving nature and its resources; developing the child's power of manipulation and the creative and inventive faculties; developing neat and orderly habits and inculcation of habits of healthful living. In addition to the objectives mentioned above, the group visualised the objectives of science teaching at the middle stage, as acquisition of a fund of information conrerning nature and science which might also serve as the basic for a later General Science course; developing the ability to reach generalisations and to apply them for solving every day problem; understanding the impact of Science upon our way of life, developing interest in scientific hobbies; and inspiring children by stories about scientists and their discoveries. (Ibid, p. 32)

The seminar thought of an 'integrated syllabus', comprising not only of subject matter but also project units, problem units, field exploration, workshop projects, teaching suggestions, equipment etc. as epitomised in the UNESCO Handbook of Science to Tropical Primary Schools, which according to the seminar was "a good model to follow." (Ibid, p. 32) The seminar not only scggested to follow the book but it recommended the translation of this book into all the regional languages.

The seminar recommended a period of one hundred hours for science teaching, of which twenty hours were to be allocated for excursions, visits, etc., fifty hours for projects and allied activities, and thirty hours for class-room teaching, discussions, demonstrations and talks. To equip the teacher fully, Teachers' Guide Books for Primary and Middle stages, along the lines of the UNESCO Handbook on Teaching of Science to Tropical Primary Schools in all regional languages were recommended to make available to each teacher of Elementary Science. Not only this the seminar went on recommending that "special training courses of not less than three months' duration be run at Training Institutions for all teachers expected to teach Science in Elementary Schools," (Ibid, p. 220) and the follow up of training course through the provision of more refresher courses for practising teachers. Besides, this "publication of a series of small, attractive and well illustrated booklets on Science topics with directions for practical activities" (Ibid, p. 220) were suggested. To teach effectively the provision of suitable reference books for teachers dealing with major areas of Elementary Science such as, Nature Study, Biological Science, Physical Sciences etc. was also recommended. The seminar did think of the position of science teaching in training schools and recommended the improvement in the science departments of Training Schools. To train the science teachers effectively the seminar thought of appointment of "a minimum of two teachers one for physical and the second for Biological Sciences in each institution." (Ibid., p. 220) The laboratories of training schools were to be adequately equipped, "at least up to the level of Higher Secondary school and facilities for training in laboratory arts and for preparing scientific aids." (Ibid., p. 220)

The seminar did not hesitate in recommending the steps to be taken up by the State Departments of Education to consider publishing teaching journals in regional languages coutaining sections on the teaching of Elementary Science. The Departments of Education were to "make grants, preferably in the form of books, for school libraries and mobile district libraries. Lists of Science Reading Marerial for children in the different languages were to be circulated to schools and local authorities with the recommendation" to purchase them for schools. A minimum of equipment and material covering activities stipulated in the syllabus (Appendix A) was to be supplied to the school authorities. A mobile laboratory containing the more expensive equipment was recommended to be set up under each Inspecting Officer (Ibid., p. 220)

Science in Higher Secondary Schools

The teaching of science at the Higher Secondary stage as recommended by Secondary Education Commission, had two aspects—one of the teaching of General Science as a core subject, compulsory for all students, and secondly the teaching of various branches of science such as Physics, Chemistry and Biology as parts of the elective science group.

The Seminar examined the Draft syllabuses prepared by AICSE and suggested to replan the syllabuses to be more in consonance with the environment and experiences of the pupils, approaches to be followed being: (i) environment centered (ii) life centred and (iii) combination of both environment and life centred approaches. The units as suggested by the seminar are given in Appendix E.

From the list of the units it appears that there was no clear-cut demarcation in environment centred approach and life centred approach. These topics had quite a resemblance with topics of School Science in American Schools, described earlier. (School Seience in America in Historic Perspective)

The recommendations made by the Taradevi Seminar indicate the dependence on the UNESCO help, assistance and guidance not only at planning level but even in case of such instructional materials and equipment which could be managed by local teachers and within the resources available in and around our schools. The knowhow and expertise as well as approaches to teaching of science as developed by UNESCO dominated the seminar. Fiftecn working papers out of seventeen and/twelve information papers out of thirteen prepared by UNESCO were circulated among the participants. (Appendix C)

The Seminar, it appears, was overpowered so by the authorities that it resolved to suggest to the UNESCO:

(i) to present one set each of all the apparatus designed by it to each of the Teacher Training Institution in India.

(ii) to prepare and make available still more blue-prints of essential science apparatus which will stimulate local enterprise to manufacture instruments according to proper specifications and standards.

(iii) to organise Refresher Courses for Science Teachers, particularly in General Science, by making available services of teachers of science from abroad.

(iv) to make available to all training institutions in India copies of its publications on the teaching and diffusion of science, and

(v) to institute fellowships and scholarships for Science teachers for further study abroad, (Ibid., p. 218)

From what went on at Taradevi, it appears that somehow we lost our perspective and our concept of the nature of school science. It seems that the idea of science teaching which A.C. Joshi pleaded was lost as the seminar progressed. As it were, the seminarians lost the sight of the jungle while they started counting trees. It appears that there were confusing if not conflicting ideas were thrown up by the organisers and the participants so that the seminar suggested sweet-sounding though vague goals which in any case, cannot be called clearcut goals rooted in our school realities.

Regarding the deliberations of Taradevi Seminar one of the participants observed that:

> the seminar did not succeed in fully expressing itself in its final recommendations . . . was only partly attributed to the status gap between the sponsors and the participants and the related authoritarian attitude of the former. (Shukla, p. 300)

From the foregoing, it appears that school science education was a problem bandied from one idea to another idea, one recommendation to the another recommendation, without keeping in view the realities of schools meant for a great majority of the people.

However, the outcome of the Taradevi Seminar was that "the syllabus pushed by and adopted in wholesale at the seminar notwithstanding considerable divergence was in many ways a half way point between the American General Science concept and the traditional subject instruction." (Shukla, op. cit. p. 300) The reason being that "no other alternative well thought out proposals were available for adoption, for want of an adequate machinery or norms of rigorous pedagogic debate and experiment." (Shukla, op. cit. p. 300)

Second Five Year Plan

The Second Five Year Plan sought "to rebuild rural India, to lay the foundation of industrial progress, and to secure to the greatest extent feasible opportunities for weaker and under privileged sections of our people and the balanced development of all parts of the country." (Planning Commission, 1956, p. XIII) Regarding the balanced development, "among other factors as in an underdeveloped economy the resources endowed by nature are not fully known, therefore, "new techniques of utilising them have to be developed." (Ibid., p. 6) So it further directed to vigilant and increasing search for discovery of new resources and for adoption or development of new productive techniques. The new productive techniques required technology which needed knowledge of science and its applications. According to the Second Plan, most important single factor in promoting economic development was "the community's readiness to develop and apply modern technology to processes of production." (Ibid., p. 6) The new Industrial Policy Resolution of Government of India (30th April, 1956) advocated that it was "essential to accelerate the rate of economic growth and to speed up industrialisation, and in particular emphasised the need for development of heavy industries and machine making industries in the public sector, though it also recommended "encouragement to cottage and village and small scale industries," which were to provide "immediate large scale employment, a method of national income, an effective mobilisation of resources of capital and skill which might otherwise remain unutilised". (Ibid, pp. 44-47)

This type of industrial development obviously, needed technical and managerial personnel and to meet the demands of human resources, it called for such knowledge, values and attitudes in the building up of which the quality of school science education was an important element.

As far as priorities in education were concerned, the teaching of crafts in elementary and secondary schools, according to Second Five Year Plan, was "one of the essential features in the reconstruction of the system of education." (Ibid., p. 510) Elementary education on basic education pattern was thought of as an area of fundamental importance in which it was necessary, for a considerable period, to experiment with new ideas, undertake pilot studies, evaluate results, and develop speedy methods to applying proven methods on a large scale. To undertake these and other tasks, the Ministry of Education set up a National Institute of Basic Education. At the secondary level, introduction of crafts and diversified courses, facilities for science teaching (introduction of General Science), establishment of multi-purpose schools and upgrading of the high schools to higher secondary schools were some of the steps proposed for implementation. In order to develop agriculture education, at the secondary stage, in rural areas, it was also proposed to provide additional two hundred agricultural courses in rural secondary schools which speaks for itself as far as plan priorities in education were concerned. (Ibid., p. 510)

The shift of priorities for development of agriculture and rural sector in the First Five Year Plan to development of heavy industries and machine making industries in the Second Five Year Plan required a shift in school science education policy too, for without a large number of skilled workers and technicalmen with a background of science education at elementary and secondary level followed by technical and vocational training in specific vocations, industrialization could not be speeded up. An educational policy which emphasised in craft centred education at the elementary level and diversified courses at the secondary level was obviously dysfunctional, though it was suited to the priorities laid down in the First Five Year Plan. Had the same priorities continued, could have, perhaps, led to the implementation of the school science educational policies laid down in the Secondary Education Commission Report. But due to shift in plan priorities from Agriculture and rural sector to heavy industries and machine making industries, the school science educational policies laid down during the First Five Year Plan lost their relevance and hence the reorientation and modification in school science educational policies was required. However, this did not happen.

Review

Looking back, the period 1952-57 will go down in educational history as the period when national efforts to improve the secondary education were mounted, The Secondary Education Commission, advocating that the link stage between school and the University was not the stage for specialization, recommended 'general science course', that is, a general introduction to all the broad and significant fields of scientific knowledge, while at the same time, it desired 'an understanding and appreciation of the fundamental principles of science.' It was not clear whether the Commission wanted general introduction to all broad fields of scientific knowledge or to provide basic understanding of fundamental principles of science· This ambiguity in policy decision was a suggestion amenable to different interpretations at the implementation stage by decision makers at the national and the state level.

The Commission's decision appears to be influenced by both the fading ideas-Progressive Education Movement (Broad Fields Curriculum) and the emerging ideas of contemporary Structure of a Discipline Movement in American Education. These American Educational ideas found an echo in the work of All India Council for Secondary Education and also at First National Seminar for Secondary Science Teaching. (Taradevi Seminar) The verbal concepts such as Integrated Courses, Nature Study, Elementary Science, Project Units, Problem Units, Units based on Environment Centred Topics, Life Centered Topics, were borrowed from the prevalent American school science literature. In the absence of clearcut directions, the courses pushed by Taradevi Seminar were in many ways a half way point between the American outgoing and contemporary school science courses as well as the traditional subject courses.

Thus, school science education policy was bandied around from one idea to another idea, from one recommendation to another recommendation leading vacillations in policy implementation.

The Central Government accepted only a limited obligations in the area of school science. Even though the Government considered essential to speed up industrialisation—development of heavy industries, machine making industries and so on for national development and prosperity, its limited obligations in education were more directed towards the implementation of Basic Education.

Thus, there appears to be a divergence between the priorities that the planners identified for the economic development and the priorities that educational decision makers set for themselves.

REFERENCES

All India Council for Secondary Education. 1956, *Proceedings of the All India Seminar on the Teaching of Science in Secondary Schools* (*Taradevi Seminar*). New Delhi: AICSE (Ministry of Education, Government of India).

All India Council for Secondary Education. 1957, *Fifth Meeting of the All India Council for Secondary Education* (*1957*) *Proceedings*. New Delhi: AICSE.

All India Council for Secondary Education (As Reconstituted). *Proceedings of the First meeting*. New Delhi: Ministry of Education (DEPSE).

Bingham, N. E., 1963, 'The Current Revolution in Science Teaching in America' in (*Improved Science Teaching in Schools*. New Delhi: NCERT.

Cremin. 1961, 'The Transformation of the School' in (*Taba*, *Hilda*, *1962*).

Government of India, 1955 Resolution No. *f*. 18-2/55-D 1 dated August, 1, 1955.

Gore, M. S. Et. al., (Ed.) 1967, *Papers in the Sociology of Education in India*. New Delhi: NCERT.

Joshi, A. C., 1965, Progress of Science Education since Independence in (*Vigyan Shikshak*, *Vol. X*, *No. 1 1966*).

Ministry of Education, 1956, *Annual Report 1954-55*. New Delhi: Ministry of Education.

Planning Commission, 1956, *Second Five Year Plan*. New Delhi: Planning Commission (Government of India).

Secondary Education Commission, (1952-53), 1953, *Report of the Secondary Education Commission*. New Delhi: Government of India (Reprint 1965, Publication No. 697)

Sharma, S. R., 1979, *American Influence on Indian Education*, New Delhi: Raaj Prakashan.

Shukla, S. 1967, 'Controls and Decision Making' in (*Gore, et. al.*, (*Ed.*) *1957*).

Taba, Hilda, 1962, *Curriculum Development*. New York: Harcourt, Brace and World. Inc.

All India Council for Secondary Education, 1956, *Third Meeting of AICSE, Proceedings*, New Delhi: AICSE.

All India Council for Secondary Education, 1956, *Second Meeting of AICSE, Proceedings*. New Delhi: AICSE.

All India Council for Secondary Education, 1956, *First Meeting of the AICSE, Proceedings*. New Delhi: AICSE.

All India Council for Secondary Education, 1956, *Draft Syllabuses for Higher Secondary Schools*. New Delhi: Government of India (Ministry of Education).

CABE, *The Proceedings of the Meeting of the CABE, 95 , 1954, 1955, 1956*. New Delhi: Ministry of Education.

Conant, James B., 1951, *Science and Common Sense*, New Haven: Yale University Press.

Chandra, Jagdish and Gupta, R. C., 1954, *An Outline of American Education*. Meerut: Senani Publications.

Department of Public Instruction, 1943, *Science and Nature Study*: Iowa Elementary Teachers Handbook. Vol. 5. The State of Iowa.

Good, H. G., 1956, *A History of American Education*. New York: The MacMillan Company.

Lester, M. Wilson and Kandel, L. L., 1934, *Introduction to the study of American Education* New York: The Ronald Press Company.

Ministry of Education, *Education in India, 1954-55, 1955-56, 1956-57, Annual Reports*, New Delhi: Ministry of Education.

Monroe, H. J., 1960, *Education in America*, New York (U. S. A.): Row, Peterson and Company.

Manson, Robert, E., 1962, *Contemporary Educational Theory*, New York: David Mekay Company, Inc.

Planning Commission, 1957, *Review of the First Five Year Plan*. New Delhi: Government of India.

Shephered, L. A. and Ritter, E. L., 1950, *Methods of Teaching in Town and Rural Schools*, New York: The Dryden Press.

Saunders, H. N., 1955, *The Teaching of General Science in Tropical Secondary Schools.* UNESCO Handbook on the Teaching of Science in Tropical Countries Vol. III. London: Oxford University Press.

Saiyidain, K. G., 1956, *Experiments in Primary and Basic Education.* New Delhi: Ministry of Education, Government of India.

Thurber, Walter A. and Collette Alfred. T., 1964, *Teaching Science in Todays Secondary Schools*, New Delhi: Prentice, Hall of India (Private) Ltd.

Walberg, HerbertJ. (Ed.), 1979, *American Education Diversity and Research* A Forum Series of the Voice of America.

Zaidi, Q. H., 1973, 'A Historical Survey of Secondary Education in India.' in (*The Fourth Indian Year Book of Education, NCERT*).

7

SCHOOL SCIENCE EDUCATION DURING 1957-62

> General Science calls for an integrated approach to all scientific knowledge and requires from the teachers a knowledge of the physical as well as the natural sciences and their inter-relationship at different stages. Such a subject is not taught in the universities, nor is its technique handled in our training college. There are no textbooks in General Science. (Nayer, 1960, p. 3)

The period 1957-62 started with efforts for the implementation of the recommendations of the Secondary Education Commission, the work on which was already initiated. An upsurge in the area of school science education not only in our country but also in the world engaged attention of science education planners to plan science education according to emerging needs. The AICSE and later on the DEPSE (Directorate of Extension Programme for Secondary Education) initiated programmes for the improvement of science education in our schools.

The AICSE set up one Committee for science education under the Chairmanship of Dr. A.C. Joshi. The first meeting of the Science Committee was held in 1957. Besides India Experts, foreign experts also participated. It also set up a three-man sub-committee consisting of Dr. R. Naidu, S.L. Mikelson and Dr. Frank Shroeder to identify the requirements of 'functionally adopted laboratories and classrooms.' The Committee discussed and recommended the provision for the manufacture of UNESCO designed instruments in the country in accordance with the suggestions made at the UNESCO International Study Conference held in 1956. (AICSE, 1957. p. 31) The Science Committee discussed the improvement in the methods of teaching of science, organisation and promotion of science clubs, evaluation of curricula in Central Science and in other areas of science such as, design and equipment of functionally adopted laboratories and classrooms, improvement of textbooks and laboratory manuals, provision of supplementary aids to science teaching (workshops, libraries, visual aids. etc.) and other matters likely to help in the improvement of science teaching in schools. The Science Committee confined itself mainly to the teaching of General Science at high school and higher secondary school level.

Scientific Policy Resolution (1958)

Another important event in the history of science education was the declaration of scientific policy of Government of India in 1958 which directed "the intense cultivation of science on a large scale, and its application to meet a country's requirements", and resolved amongst other things:

> —to foster, promote and sustain, by all appropriate means, the cultivation of sciences, and scientific research in all its aspects—pure, applied and educational;
>
> —to encourage and initiate, with all possible speed, programmes for the training of scientific and technical personnel, on a scale adequate to fulfil the country's needs in science and education, agriculture and industry, and defence;
>
> —in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge. (Government of India, 1958. par. 7)

These tasks, specially the task, "to encourage and initiate . . . programmes for the training of scientific and technical personnel," had far reaching implication for science education policy at school level. Improvement in science education implied the improvement in curriculum and teaching methods apart from other aspects of science education. The Report on Improvement of Curriculum in Indian Schools by Henry Harap came out by this time who studied the curriculum of Indian Schools under UNESCO programme. He found that "teaching of science in primary schools is usually bookish" and "many teachers of science are not sufficiently trained to give them the confidence and ability to teach the subject satisfactorily." (Harap, 1959. p. 39)

The science curriculum itself was a hotch potch of Subject Curriculum, Broad Fields Curriculum and Unit Curriculum. The situation in school science curriculum policy was in no way related to declared Scientific Policy Resolution of Government of India in 1958, nor any efforts were made to rationally work out school science curriculum policy keeping in view the recommendations of the Scientific Policy Resolution (1958). For instance, a scheme to improve science education in our country was started in 1956. The Government of India for strenthening of Science Teaching in secondary schools deputed training college lecturers and secondary school teachers, under the Teachers Fellowships Programme to visit U.S.A., Canada and U.K. The teachers were selected from various training colleges and secondary schools and were sent to study science teaching programmes in these countries. The teachers studied the methods and practices adopted in the schools and teachers training colleges of these countries. They also familiarised themselves with the total school curriculum and the place of General Science in it, as well as the courses for teachers's training. On their return in order to utilise the special experience and knowledge of the teachers deputed abroad towards the immediate improvement of science education in the country, a seminar was, therefore, organised in July, 1959, wherein the group of these teachers reviewed their experiences abroad and suggested measures which

State Education Departments of the Ministry of Education could adopt for improving the teaching of science, in secondary schools taking into consideration our needs and the resources available in this country as well the emerging pattern of science education abroad. (DEPSE, 1959)

One of the major recommendations of the group was the appointment of a Science Education Commission by the Government of India for the purpose of obtaining expert assessment of the existing position of science education at all levels as well as an expert formulation of a comprehensive programme for the immediate future. They also recommended the setting up of a Central Institute of Science Education for developing a valid body of knowledge in school science education as well as a scheme for training personnel through regular vocation and part-time courses, and to carry out research studies in curriculum, methods, equipment, teaching aids, evaluation etc.

For the preparation of instructional materials, the group recommended such steps as were taken up in U.S.A. and U.K. to be undertaken in India by agencies like the All India Science Teachers Association, the Directorate of Extension Programmes for Secondary Education, the (proposed) Central Institute of Science Education. The group also recommended appointment of Science Development Officers in the different states of India on the pattern of Inspectors in the developed countries, such as, U.S.A. Canada, and U.K. (DEPSE, 1959)

The group found that for the primary (junior basic) stage, the objectives, content, duration and programmes, for General Science teaching as defined by the Taradevi Seminar of 1956, adequate and suitable. For the middle (senior basic) stage, the group suggested the additional objectivs—acquisition of functional information, and appreciation of the contributions made by famous scientists. For the high school/higher secondary (post basic) stage, the information, concept and principles taught were recommended to be made functional, and to develop instrumental and problem-solving skills and scientific attitudes and appreciations among the students. The same science content was recommended for the attached eighth standard in the high school and for the terminal eighth standard in the middle school. For students in the multi-purpose school who were in streams other than science electives, General Science was recommended to be a compulsory subject for all the four years. (DEPSE, 1959)

The observations and recommendations of the group if presumed to be an indicator of the kind of thinking regarding school science education policy amongst educators, then it appears that science educators did not perceive the implications of Scientific Policy Resolution of Government of India (1958) whereas the group of secondary school teachers and teacher educators tended to reiterate the general science curriculum policy enunciated by the Secondary Education Commission. The Scientific Policy Resolution (1958) indicated towards a new approach in School Science Education Curriculum Policy in tune with the priorities for heavy and machine making industries in the Second Five Year Plan. This would be more apparent if we look at the implementation of policies of Goverment of India regarding education at various level.

Science Teaching under the National Basic Education System

Major efforts to improve general science teaching in school as envisaged in National Basic Education System were mounted during the period 1957-1962. In 1956 Saiyidain, the then educational adviser, Government of India observed:

> Theoretically speaking the General and State Goverments have all accepted that the pattern of our mass education should be basic. Various Committees and conferences as well the CABE have endorsed this policy. But practice continues to lodge deplorably behind the theory and in many States no serious and well planned effort has been made to bring about the necessary change. (Saiyidain, 1956).

However, inspite of such a dismal situation in practice, efforts were made to expand and establish Basic Education

System in the country. As mentioned earlier, National Institute of Basic Education was established in 1956 to work towards the improvement in Basic Education. Instructional materials and other guide materials such as how to teach general science in basic schools and how to correlate science teaching with other subjects were prepared. Mention may be made of instructional materials such as 'General Science—Handbook for Teachers of Basic Schools (Patil, 1956), Local Environment—A Source of Education (Acharlu, 1959), Teaching through Environment in the Urban Basic Schools (Chikermane, 1959), Kitchen Gardening in Basic Schools' (Choudhari, 1970), Organisation of a curriculum for Basic Primary Schools based on a study of Natural Environment (Acharlu, 1961), Basic Science Teaching in Social Perspective (Shukla, 1961), Position of Science Teaching in Schools (Mukherjee, 1962), An analysis of Science Textbooks (Wanchoo, CBTR—CIE), Criteria and Score Card for Evaluating General Science Textbooks for Primary Schools (Wanchoo, CBTR—Ministry of Education). By going through the materials prepared for General Science teaching one may find that stress was on the teaching of science as a subject correlated with other subjects.

About the correlation of one subject with craft or another subject, Sargent (1939) observed that "we should not allow ourselves to be unduly impressed by the word 'correlation'. After having tried his hand at making primary school teachers in U.K. appreciate the importance of correlating the subjects taught with basic craft, to his dismay he found that "education is not a jigsaw puzzle into which all the pieces will fit in naturally and completely." (One Step forward, p. 260) Inspite of the fact that Ministry of Education circulated 'The Concept of Basic Education' which made significant observations towards correlation in school corriculum, the jigsaw puzzle of correlating subjects with crafts in which all pieces would fit, could not be solved. If one were to go by the observations of Basic Education Assessment Committee, School Science at most of the places was just a part of Subject Curriculum. There was little of correlating but that too was not with crafts or natural environment or Social environment but with other subjects. Within the science subjects the instructional material made available by various agencies including National Basic Institute, Central Bureau of Textbook Research etc., had little to show that attempts were made either to correlate or integrate or fuse various science concepts with natural environment or social environment or amongst themselves.

Science Education at the Secondary Level

During the earlier part of the period 1957-62, the All India Council for Secondary Education (AICSE) undertook various programmes to improve the school science through its extension programme projects. In 1959, the AICSE was reconstituted as a purely advisory body and the Directorate of Extension Programme for Secondary Education (DEPSE) was established as an executive organisation to implement the approved schemes in the field of secondary education. As discussed earlier, these extension services centres attached to various teachers training institutions carried on in-service training for secondary school teachers through seminars, workshops and allied programmes. These Extension Centres were provided with a lot of equipment and a variety of instructional materials and library books under USAID Scheme. It was with the help of this hardware and guidance from American experts attached with Teachers College, Columbia University Team in India that the Field Advisors in the DEPSE and the Honorary Directors and Coordinators of the Extension Centres were able to formulate and carry out various programmes. It was through these programmes that they tried to keep secondary school teachers abreast of the accepted ideas in educational theory and practice, with a view to help them to improve themselves in their professional work. This also helped the teachers training institutions to come in touch with the problems of secondary schools in their area and in orienting the teacher education programmes torwards the emerging professional needs of the teachers as visualised by the field staff.

Another programme undertaken by DEPSE in cooperation with foreign experts was organisation of various types of workshops, seminars and conferences on an All India, State and

Regional level to bring together headmasters, teachers, educational administrators and university teachers to deal with problems of common educational interest. Seminars of secondary school subject teachers were held to help them understand the new goals of secondary education and to acquire skills in appropriate methods of instruction and improved techniques of evaluation. To improve the techniques of evaluation, DEPSE took to the programme of examination reform drawn up under the guidance of Dr. B. S. Bloom of University of Chicago. A large body of secondary school teachers and educators were oriented towards the new evaluation techniques. Through seminars, a large number of test items, evaluation tools reflecting the new objectives of science teaching were prepared. (DEPSE, 1960, pp. 103-149)

Another programme of the DEPSE was aimed at introducing experimentation in schools. Dr. Stephen M. Corey helped in disseminating the concept of 'action research' to improve school practices among secondary school teachers and teacher educators. Under this programme, financial assistance was given to enterprising schools which undertook projects intended to bring about improvement in classroom instruction or in school organisation. Few projects were taken up in the area of teaching general science.

In view of the slow progress made in the implementation of the recommendations of Secondary Education Commission, the DEPSE conducted a sample survey of the multi-purpose schools in the country in 1959. Based on this survey, a programme was visualised for the strengthening of the multi-purpose schools especially in regard to the preparation of teachers in practical subjects.

In pursuance of CABE's recommendations (1959) each State Government was requested by the DEPSE to recommend about two per cent of the secondary schools in the State for establishment of Science Clubs. The DEPSE provided financial help to such science clubs. Central Science Clubs in training colleges having Departments of Extension Services were expected to provide training to the teachers in charge of science clubs in these schools and also to serve as workshops for the teachers working in the associated Central Science Clubs. To monitor and carry out the various science programmes specifically, a Science Unit was established in the DEPSE.

However, neither the Science Unit (DEPSE) nor the various Extension Centres were definite about the content of programmes of improvement in science teaching. This was so, because education being the State subject, the recommendations of Secondary Education Commission did not find ready acceptance. Some of the states like Delhi which had adopted a higher secondary pattern earlier or Madhya Pradesh which had yet to expand secondary education, switched over completely to the higher secondary pattern. States like West Bengal, Rajasthan, Punjab made an attempt to adopt the secondary pattern and continued as well with the old high school pattern. Finally states like U.P. Kerala, Maharashtra completely ignored the new pattern and continued with the old pattern. The upshot was, that out of 22,883 schools, hardly 2,115 schools could be converted to multi-purpose schools at the end of the Second Five Year Plan and as pointed out by Srivastava, most of these schools did not offer more than two optional courses—Humanities and Science. (Srivastava, 1963, p. 282)

Thus, the old subject-curriculum in science, science for tropical countries programme and general science and science programme in various states according to the recommendations of Secondary Education Commission were running concurrently. Though the Scientific Policy Resolution (1958) entailed a review of the school science education policy at Secondary level in order "to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge", not much could be done simply because there was no move for a concerted effort to arrive at a common science education policy. Perhaps, the variety and diversity in science education programmes in various states and within a state precluded the possibility of visualising such a need. For instance, in pursuance of the Secondary Education Commission's recommendations, all students in the secondary stage had to study general science as a compulsory subject. In some Southern States a composite course in science, more or less of the elective standard was provided as a compulsory subject for all secondary school students. (Nayar, 1960, p. 2) However, there were difficulties in the implementation of teaching general science in the States of Assam, Maharashtra, U.P., Gujarat, Delhi and other Union Territories. The major difficulty in this regard was the dearth of teachers of general science, textbooks in general science, duration of school structure and resistances from the State administration.

All India Science Teachers Association (AISTA) Conference while reviewing the reorganised secondary syllabus in General Science observed:

(i) As the course is composed from many science fields, teachers are generally hesitant to deal with portions relating to sciences which they have not themselves studied for their university degree.

(ii) On this ground as well as because of their experience of studying separate sciences, possibly in a logical sequence, teachers find it difficult to integrate the material from many sciences into a single investigation on the one hand or to integrate the material with life situations on the other. (Report of the Conference, 1961. p. 25)

On the other hand, the Chairman University Grant Commission, while addressing the annual conference of AISTA in December, 1961, and high-lighting the role of science and technology for national prosperity stressed to modernize the school science curriculum as in U.S.S.R. He observed:

> In the teaching of physics (and for that matter any science subject) great stress has to be laid on clarity of presentation, inclusion of adequate, but not over much, mathematics and encouraging the student to think and apply the fundamental principles to concrete situations. (Kothari, 1961, p. 3)

The team of experts which was sent to U.S.S.R. under the leadership of Prof. Humayun Kabir had already reported that science was taught there as individual disciplines (subjects) right from middle stage. This combined with Scientific Policy Resolution of Government of India (1958) represented a current of thought which anticipated the structure of discipline approach of teaching science. Thus there were parallel and contending view points on school science education policy, the lines between and amongst which were not very clear. This was so because the science policy decision makers, economic development planners, educators and adminstrators viewed requirements of scientific knowledge from their own point of view and there was no agency either to coordinate or to act as clearing house to build a national consensus.

The upshot had been well summarised by the Committee on Emotional Integration popularly known as 'Sampurnanand Committee' (1962) when it observed:

> Most of policies and programmes suggested on the recommendations of the numerous committees and commissions appointed by the Government of India from time to time since independence remain unimplemented for one reason or the other. It would appear, therefore, that neither at the Centre nor in the States there has been a proper correlation of the policies enunciated and the programmes taken up for implementation. . . . The State Governments naturally are aware of their own educational problems and are critical of the manner in which their proposals are modified or amended by the Centre. It is felt that such amendments are often made more on financial rather on educational grounds. The Centre on the other hand feels that its advice and help to the States is not fully appreciated. We cannot escape the conclusion. therefore, that the function of policy making and finalising of progarammes to implement such policies has not received adequate attention during these 15 years, (Cited by IPSC (1964) p. 33)

Third Five Year Plan

Towards the end of the period 1957-62 deliberation on the Third

Five Year plan started. The major themes were centred around state of agricultural economy, the developing industry, power and transport, hastening the process of industrial and technological change, achieving marked progress towards equality of opportunity providing employment for all etc. The main aims in the Third Plan were subsequently identifid as follows:

(i) to secure an increase in national income of over five per cent per annum. the pattern of investment being designed also to sustain this rate of growth during subsequent plan periods;

(ii) to achieve self sufficiency in food grains, and increase agricultural products to meet the requirements of industry and exports;

(iii) to expand basic industries like steel chemical industries. Fuel and power and establish machine building capacity, so that the reqirements of further industrialization can be met within a period of ten years or so mainly from the country's own resources;

(iv) to utilise to the fullest extent possible the men-powerl resources of the country and to ensure a substantia expansion in employment opportunities and;

(v) to establish progressively greater equality of opportunity and to bring about reduction in disparities in income and wealth and a more even distribution of economic power. (Planning Commission, 1962. p. 17)

Thus in the scheme of development during the Third Plan, agricultural production was to be increased to the 'highest levels feasible'. As the growth of agriculture and development of resources alike hinged on the advance made by industry, the growth of industry was to be speeded up, and in particular heavy industries and machine making industries were to be developed. Obviously the skilled manpower was the requirement to handle all the machineries in the factories, mills and Karkhanas. For ensuring a fair balance between economic and social development and equally, for realizing the economic aims, considerable emphasis was given to the development of education and other social services. (Ibid, p. 18).

In the field of general education, as distinguished from, technical education, the main emphasis in the Third Plan was on:

> The provision of facilities for education of all children in the age-group 6-11, expansion and improvement of the teaching of science at the secondary. . .development of vocational and technical education at all levels, expansion and improvement of facilities for training of teachers for each stage of education . . . conversion of all elementary schools on basic pattern, remodelling all training institutions along basic lines, establishing basic schools in urban areas and linking up basic education with the developmental activities of each local community. (Ibid, pp. 151-152)

According to this perception, inspite of the fact that basic education pattern was not taking the roots as brought out by the Assesment Committee, the Planning Commission still persisted in encouraging efforts to expand it further. Regarding Secondary Education, secondary schools were to be so reorganised that they could provide a diversified educational service to pupils according to their needs. Among the measures envisaged in the Third Plan were:

> The conversion of high schools into higher secondary schools, development of multipurpose schools with provision of a number of elective subjects and in the consolidation of the scheme by strengthening the 2115 institutions already established and to 331 new schools, an integrated teacher training programme for the multipurpose schools through the four regional training colleges. Expansion and improvement of facilities for the teaching of science, provision of educational and vocational guidance, improvement of the examination and evaluation system, enlargement of facilities for the education of girls and the backward classes and

> encouragement to merit through scholarships. (Ibid., pp. 153-154)

Though high priority to the expansion and improvement of science education at the secondary level was given during the Second Plan period, a considerable proportion of schools lacked the basic minimum requirements in respect of laboratories, eqipment, suitable textbooks and hand books, and properly qualified and oriented science teachers. So in the Third Plan to improve science teaching, various measures were proposed such as:

> Review of the existing science syllabi, preparation of teachers hand-books, students manuals and science text-books, augmenting the supply of science teachers, training of laboratory assistants, standardization of designs of science apparatus, providing general science in all secondary schools as a compulsory subject (Ibid, p. 154)

In order to coordinate, guide and direct the entire programme of science teaching as well as the training of key personnel, a central organisation for Science Education was also proposed. Special emphasis was proposed to preservice training of teachers in Science, introduction of new techniques of evaluation, provision of a variety of special subjects such as guidance and audio-visual education and the organisation of research. The extension Centres Scheme was proposed to be extended to a large number of trainning colleges during the Third Plan with the ultimate object of making extension service an integral part of the work of every training college.

In the Third Plan Science facilities at the collegiate level were proposed to be expanded with a view to raise the percentage of science students to forty at the end of the Third Plan. In addition, four Regional Institutes for the training of teachers were proposed to be set up to prepare teachers for practical streams, including the science stream, of the multipurpose schools.

The other problems which were posed to be tackled in the Third Plan for improving teaching of science in secondary schools were: dissemination of improved methods of science teaching in schools, preparation of model textbooks, evolving standard inexpensive science equipment for use in various schools, evolving better methods in the use of laboratories, orienting existing programmes in extension centres with main emphasis on improvement of science teaching, establishing a special science unit in Directorate of Extension Programme for Secondary Education and conducting research and experiments in methods of science teaching. The dearth of equipment, especially manufactured in the country was also felt. The All India Council for Secondary Education's recommendations to standardise the designs of science apparatus and arrangements to be made for distributing equipment to educational institutions, to place orders for a period of years ahead on existing or potential manufacturers in the country to enable them to gear up their machinery to meet the demand to a large extent, were to be dealt. Some equipment for schools and training colleges were suggested to be imported. To sufficiently stimulate potential talent, a more informal education in science through science clubs, fairs, was considered to be essential for the purpose of which the beginning was made in the Second Plan.

It appears that Third Plan priorities were to improve the general science curricular trend of teaching science as envisaged in National Basic Education system and as recommended by Secondary Education Commission while in the practice the debates on the teaching of science as general science or as individual discipline approach continued and the divergence between the priorities that the planners identified for the economic development and the priorities that educational decision makers set for themselves appear to have persisted.

Review

Looking back, during the period 1957-62, the major school science curricular trend which appears to have persisted was general science programme. Government machinery made efforts to implement the policy decisions of Secondary Education Commission into practice. However, the discipline approach of teaching science (concept teaching approach) slowly but surely managed to emerge. Its echo could be heard in various seminars where in its voteries appear to be elitist science educators. The Government Policy Resolution (1958) too tended to tilt the debate towards this approach. The Second Five Year Plan priorities and subsequently the proposals made in the Third Five Year Plan which stressed heavy and machine making industries also favoured a school education with an orientation of science teaching towards subjects or discipline approach.

The recommendations made by a group of secondary school science teachers and teacher educators in the seminar 'Strengthening Science in India' did not appear to have percievd the school science education policy clearly. The group, on one hand, tended to reiterate the general science curriculum policy enunciated by the Secondary Education Commission, and, on the other hand, recommended that the science courses should be at par with the school curricula of developed countries which had by then adopted a concept approach to teaching of science.

It appears that science teachers, educaters and planners did not percieve the implications of the priorities of Second Five Year Plan, proposed priorities in Third Five Year Plan and the Scientific Policy Resolution of 1958, during the period under review. For instance, at the primary school level, the National Institute of Basic Education tried to popularise the general science approach and suggested programmes of science teaching in correlation with other subjects. Inspite of the dismal situation, Basic Education pattern continued to be supported even though no serious and well planned efforts were made to bring about necessary changes. Government machinery continued to work the way Assessment Committee described its working. Science teaching in schools was still bookish though efforts were made to popularies its practical oriented aspects and to correlate or to integrate it with other subjects and environment.

DEPSE undertook various programmes to improve secondary school science education according to the recommendations of Secondary Education Commission. In this, the USAID and American experts too contributed. Its programmes on science teaching were based on general science approach. The hindrances such as, questionable academic competence of teachers, non-availability of an adequate number of professionally competent general science teachers, non-availability of proper textbooks in general science and other instructional materials, resistance from state administration, the varied school systems in the states etc., in carrying out the recommendations of Secondary Education Commission were pinpointed and discussed in various seminars and conferences by groups and individuals. It appears, these were also one of the reasons to carry the debate towards an orientation to science teaching in schools towards a discipline approach or concept approach.

This, perhaps, happened because of absence of the proper experimentation in the field of school science education for effective planning and implementation. The divergence between the priorities that the planners identified for the economic development and the priorities that educational decision makers set for themselves persisted. There appeared a hiatus between the identified objectives of planned development and the decided educational programme priorities. Perhaps, because of this hiatus between the planning priorities and implementation priorities of educational programmes that to improve school science education appear to be half-hearted and a clearcut school science education policy could not emerge as the parrallel and contending view points on school science teaching continued to engage educational decision makers attention.

REFERENCES

Acharlu, K. S., 1959, Local Environment—A Source of Education (*Buniyadi Talim—Vol. II No.* 1, *pp*. 11-14).

Acharlu, K. S. 1961, Organisation of a Curriculum for Basic Primary Schools based on a Study of Natural Environment in (*Buniyadi Talim. Vol. IV No.* 1, *Jan. 1961. p. 57*).

All India Council for Secondary Education, 1957, *Proceedings of the First Meeting of the Science Committee*. In Vigyan Shikshak, Vol. I. No. 4, pp. 31-36.

All India Science Teachers' Association., 1961, Review of the Working of the Reorganised Secondary School Science Syllabi—working papers for Udaipur Conference, 1961, (*Vigyan Shikshak Vol. V. No. 3, pp. 20-32*).

Central Advisory Board of Education (CABE). 1961, *Proceedings of the Meeting*. New Delhi: Ministry of Education (Government of India).

Chikirmane, D. V. 1959, Teaching Through Environment in the Urban Basic Schools. (*Buniyadi Talim Vol. II, No. 4*, p. 158)

Choudhari, B. R. 1960, Kitchen Gardening in Basic Schools (*Buniyadi Talim, Vol. III, No.* 3, *July, 1960*. p. 25)

Directorate of Extension Programmes for Secondary Education (DEPSE). 1959, Strengthening Science Teaching in India (*Teacher Education*. Vol. III, No. 8. DEPSE (Government of India, August, 1959).

Directorate of Extension Programmes for Secondary Education (DEPSE). 1960. *Evaluation in Secondary Schools*. New Delhi: Ministry of Education, Government of India.

Directorate of Extension Programmes for Secondary Education (DEPSE). 1962. *All India Conference of Honarary Directors and Coordinators Extension Service Centres*. New Delhi NCERT.

Government of India. 1958, *Scientific Policy Resolution*, (*1958*).

Harap, Henry, 1959, *Improvement of Curriculum in Indian Schools*. Ministry of Education, Government of India.

Indian Parliamentary and Scientific Committee (IPSC). 1964, *Report Science Education in Schools*. Government of India. (NCERT. Reprint 1965).

Kabir, Humayun et. al., 1957, *Trends in Soviet Education*. Delhi: Ministry of Education and Scientific Research. (Government of India).

Kothari, D. S. 1961, Presidential Address. Some Problems in Secondary Science Education. Sixth Annual Conference of All India Science Teachers' Association. *Vigyan Shikshak, Vol. VI. No. 1* (*1962*).

Mukherjee, S. C. 1962, Position of Science Education in Primary Schools and the Training of Teachers' in (*Buniyadi Talim, Vol. V, No. 3, July 1962*).

Nayar, D. P. 1960, *Third Plan Programmes for Strengthening Teaching of Science in Schools*. in Vigyan Shikshak Vol. IV; No. 4.

Patil, B. R. 1956, General Science in *Hand Book for Teachers of Basic Schools*. Delhi: Ministry of Education and Scientific Research, Government of India.

Saiyidain, K. G. 1956, *Proceedings of the Educational Conference for Southern Region*. Coimbatore: p. 23. Sri Ram Krishna Vidyalaya.

Sargent John, 1939, *One Step Forward. The Report of the First Conference of Basic National Education (Poona)*. Sevagram, Wardha: Hindustani Talimi Sangh.

Shukla, S. C. 1961, 'Basic Science Teaching in Social Persepective' in *Buniyadi Talim, Vol. IV, No. 3 July, 1961*, pp. 136-137).

Srivastava, B. D. 1963, *The Development of Modern Indian Education*. Calcutta: Orient Longman.

Wanchoo, V. N. *An Analysis of Science Textbooks*. Delhi: Central Institute of Education.

Wanchoo, V. N. *Criteria and Score Card for Evaluating General Science Textbooks for Primary Schools*. Delhi Ministry of Education (Government of India).

Assessment Committee on Basic Education, 1957, *Basic Education in India, Report of the Assessment Committee on Basic Education*. Delhi: Ministry of Education and Scientific Research (Government of India).

Basic Education Board (Bihar), 1957, *Buniyadi Shikshan Paddati*; (Basic Method of Teaching Mother-tongue, Mathematics, General Science, Social Studies, Arts and Crafts work, Drawing, Physical Education and Music).

Basic Education Review Committee, 1962, *Report*, Government of Maharashtra.

Basu, K. P. and Mukherjee N. K., Science in Secondary Education (Vigyan Shikshak, Vol. V, No. IV, p. 1).

Board of Secondary Education, Rajasthan, *Objectives of Teaching General Science and the Break-up of its Syllabus for Secondary classes*. Ajmer: Board of Secondary Education, Rajasthan, Ajmer.

Bombay Integration Committee, 1958, *Report of the Committee for Primary Education*, Bombay: Government of Maharashtra. (p. 575).

CABE, The Proceedings of the Meetings of CABE, *January, 1953, January 1957, February 1958, January 1959, February, 1960, January 1961. January 1962*. Deihi: Ministry of Education (Government of India).

Committee on Plan Projects, 1962, *Report on Science Laboratories and Equipment in High/Higher Secondary Schools.* New Delhi: Government of India. (copp/ss/1962/I).

Dar, J.L. Science and Education (*Vigyan Shikshak, Vol. II, No. 1. 18*).

Department of Extension Service, *Science Teaching.* Delhi: Central Institute of Education

DEPSE, 1961, *Evaluation in General Science* (Prepared by R. H. Dave and D. G. Kulkarni) New Delhi DEPSE (NCERT).

Emotional Integration Committee; Sampurnanand Committee 1962. Report in (B. D. Bhatt and Aggrewal, J. C. (Ed.) 1977. *Educational Documents in India* 1813-1977. New Delhi: Arya Book Depot.

Green, T. L. Scientific Teaching of Science *Vigyan Shikshak Vol. II, No. 1 p. 15.*

Harinath, N.R. Some Problems of Basic School Science Textbooks. (*Vigyan Shikskak, Vol III, No.* 3 *p.* 6).

Hussain, Zakir 1959, *Educational Reconstrucion in India*: (Sardar Vallabh Bhai Patel Lectures). New Delhi: The Publication Division, Ministry of Information and Broadcasting, Government of India.

Jayanti, V. Science Syllabus for Higher Secondary Schools in Andhra Pradesh *Vigyan Shikshak, Vol. VI, No. 1 p.* 37.

Joshi, A. C. Some Fundamental Problems of Science Education in the Elementary and High Schools. *Vigyan Shikshak Vol. I, No. 2, p. 2*).

Joshi, A. C. Science Education in Schools. (*Vigyan Shikshak Vol. II, No.* 1 *p. 6*).

Joshi, A. C. Some Problems of Science Education in the Elementary and Secondary Schools (*Vigyan Shikshak, Vol. III, No. 4*)

Joshi, A. C. Science Teaching Under the Changing Pattern of Secondary Education, *Vigyan Shikshak, Vol. VI, No. 1, p. 11.*

Khosla, A. N. Problems of Science Education. (*Vigyan Shikshak, Vol. V, No,* 1, *p.* 1).

Kothari, D.S. Some Problems in Secondry Science Education. (*Vigyan Shikshak, Vol. VI, No. 1, p. 1*).

Loria, B. D. Science Teaching in Secondary Schools: (*Vigyan Shikshak, Vol. IV. No. 1. p. 25*).

Ministry of Education, *A Review of Education in India 1957-58.* Delhi: Government of India (Publication No. 361). *Annual Report, 1960-61, 1961-62.* Delhi: Government of India.

Ministry of Education, 1960, Central Advisory Board of Education. *Silver Jubilee Souvenier.* Delhi: Manager of Publications, (Government of India).

Ministry of Education and Scientific Research, 1958, *Annual Report, 1956-57.* Delhi: Government of India (Publication No. 286).

Ministry of Education, Conferences of Education Ministers (Second September 1956), (Third September 1957), (Fourth August 1959), (Fifth Nov. 1960), (Sixth, Oct. (1962) in (Biswas, A and Agrawal, Suren (Ed.). *Indian Education Documents Since Independence.* New Delhi: The Academic Publishers India.

Mittal, D. S. Present Position ofScience Teaching, Suggestion for Improvement in (Vigyan Shikshak, Vol. III, No. 11, p. 36).

Mudaliar A. L. Some Aspects of Science Education, (*Vigyan Shikshak, Vol. II, No 1, p. 1*).

Nagchowdhury, B. D. School Science Education as a Foundation for Higher Science and Technology. (*Vigyan Shikshak, Vol. III, No. IV. p. 1*).

Nayar, D. P. and Dhar T. N. 1965, Basic Education Programmes—Major Issues. in (*Buniyadi Talim, Vol. VIII, No. 1*; *January, 1965*).

NCERT, 1970, *Report on Science Education in the Regional Colleges of Education.* New Delhi: NCERT.

NCERT, (DEPSE) 1962, *Science Education in the Regional Training Colleges*, New Delhi: (NCERT).

NCERT, 1963, *Plan and Programme Regional Colleges of Education.* New Delhi: NCERT (Regional Colleges Unit).

Rao, D. G. Middle School Science, Assetor Liability in High School (*Vigyan Shikshak Vol. I, No. 3, p. 25*).

Richardson, J. S., Secondary School Science Teaching, the Consequences of Contemporary Advances in Scientific Knowledge in: (*Vigyan Shikshak, Vol. III, No. IV, p. 8*).

Salamatullah, 1963, *Thoughts on Basic Education*, New Delhi: Asia Publishing House.

Siksha Vibhag Rajasthan, 1957, *Akhil Rajasthan Pratham Buniyadi Siksha Seminar*. Udaipur: Shiksha Vibhag.

Science and Education; Policy Statement of Science Master's Association of England. (*Vigyan Shikshak Vol. VI, No. 2* p. 20).

Shukla, S., School Science Education, A Developmental Programme in, (*Vigyan Shikshak, Vol. IV, No. 1, p. 9*).

Shukla, S. Science in Basic Schools, (*Vigyan Shikshak, Vol. I. No. 1, p. 14*).

Shukla, S. Trends in School Science Curriculum (*Vigyan Shikshak, Vol. IV, No, 1, p. 41*).

SubhaRao, C. S., 1958, *Basic Education in Practice*. Secunderabad: Ajanta Publications.

Tandon, B. C. 1970, *Economic Planning*, Allahabad: Chaitanya Publishing House.

Wanchoo, V. N., Curriculum Improvement in Science—An Attempt (*Vigyan Shikshak, Vol. I, No. 3, p. 14*).

Wanchoo, V. N., Contents of Science Textbooks, Presentation for the Elementary and Basic Schools. (*Vigyan Shikshak Vol. II, No. IV, p. 9*).

8

SCHOOL SCIENCE EDUCATION DURING 1962-67

> In the lower primary classes science teaching should be related to the child's environment . . . At the higher primary stage emphasis should be on the acquisition of knowledge and the ability to think logically, to draw conclusions and to make decisions at a higher level, A disciplinary approach to the teaching of science will be more effective than the general science approach. At the lower secondary stage, science should be developed as a discipline of the mind. (Education Commission, 1964-66, p. 394)

This period started with a variety—mainly two contending thoughts on teaching science at school stage—especially at middle stage. Some thinkers were still in the favour of general science approach and some were advocating an entirely new approach—the structure of a discipline approach, to teach science at school stage. The NCERT set up a Science Committee under the Chairmanship of Prof. P. C. Mahalanobis, Member Planning Commission and one of the architects of industrial revolution in India. The Science Committee was set up for the purpose of enquiring into and recommending measures for the improvement and expansion of teaching of science at all stages of education, particularly at the school level, for developing scientific talent in the country and for the training of science teacher.

The first mceting of the Committee was held in July, 1962. Detailing the scientific base of economic development in the advanced countries as well as in the less advanced countries and highlighting the features of programme of technical assistance, Mahalanobis (1962) observed:

> In the highly developed countries science advanced both from progress at the highest levels of research, at the top, and from the wide diffusion of education, at the bottom. The same strategy may be adopted with advantage in the less advanced countries. What is urgently needed is to lay the foundations, with as wide a base as possible for a countrywide svstem of school education oriented to scince and, at the same time to develop advanced studies of science and technolgy and research at the highest level. The school system must fit into the economic life of the general mass of the people and have its grass roots in the villages. It must offer facilities for training technicians and technical personnel for science and technology and also supply candidates of outstanding merit for admission to higer scientific and technological institutions. (The scientific Base of Economic Development, p. 18)

Visualizing aid in terms of eqipment and expertise from advanced countries for development of science in the country, Mahalanobis stressed "the need of building up a system of school education with a definite orientaion to science." (Ibid, p. 19) To build up such a system, he cautioned not to copy the model of advanced countries but advised to "evolve a system through experimentation and trial and success, which would be within the means of the national economy." (Ibid, p. 19) He observed that "it would be, however, a fatal mistake to establish an expensive system of education on the model of the advanced countries which would have little relevance to local needs and would be beyond the means of national economy." (Ibid, p. 19) The approach suggested was to use locally available indigenous teaching aids, or low-cost aids. He argued in favour of agriculture and other rural industries becoming the base for science teaching for the large majority of children. Mahalanobis was hopeful of possibilities to evolve to broad general methods for science education which would be capable of being adopted without much difficulty to suit differing local conditions. Mahalanobis also suggested programme for the preparation of books of instructions and such textbooks which would suit a fairly wide range of needs.

Position of Science Teaching in Schools

The DEPSE conducted a survey to reveal the position of science teaching in Indian Schools for the first time.

According to 'A Factual Report—Position of Science Teaching in Indian Schools' (1962) Science was taught in some form or another viz., Nature Study, Health and Hygiene, General Knowledge. Elementary Science or General Science upto the end of primary education in all states. At the middle schools stage General Science was a compulsory subject in all states except Madhya Pradesh and Uttar Pradesh. In Madhya Pradesh, General Science was an optional subject, the other options being Music, Home Science and Drawing, although in actual practice this option was exercised mainly in rural areas. In Uttar Pradesh, General Science was accepted as a compulsory subject in the syllabus for this stage, but where facilities for teaching Genral Science did not exist, the department had directed that a local craft In lieu of it could be taught. In the case of Delhi Territory and Marathwada, girl pupils of middle schools were expected to take Domestic Science in lieu of General science. It had significant consequences for education of girls in sciences at the higher secondary level. Girls, who wished to take up science courses at the higher secondary school, found themselves at a disadvantage since they had no science instruction at the middle stage. To avoid this, a provision was made in Delhi territory to allow girls to study General Science at middle stage in addition to domestic science. The position of science at higher stage was different depending upon whether it was the high school or higher secondary school. At the high school stage, science was provided as (i) compulsory for every pupil generally termed as General Science or Everyday Science or (ii) as in opional—Physics, Chemistry and Biology or, (iii) certain courses as compulsory and certain others as optional.

Science at the higher secondary stage was provided both under the core and under the elective programme, except in the case of Madras, Kerala and Uttar Pradesh. In Punjab, Rajasthan, Assam, West Bengal, Madhya Pradesh, Jammu and Kashmir and Andhra Pradesh, every pupil studied General Science as a compulsary core subject whatever optional subjects he might select. In Bihar, however, a student offering Natural Science group as elective was not required to offer General Science. In the case of Telengana the pupil who took elective science studied General Science for one year in standard IX. Out of these seven states in all, except Telengana, Bihar, and Assam, General Science as a core subject was taught only upto Standard X. In the case of Telengana those who did not offer elective science studied General Science and offered it at the external examination at the end of Class XII. (NCERT. 1962, Position of Science Teaching in Indian Schools—A Factual Report, Passim, pp. 33-41)

Thus General Science was the accepted curricular trend in science teaching at School Stage. Accordingly steps were taken by the Centre to strengthen science teaching in schools in areas such as curriculum, textbooks, laboratories and equipment, teaching aids, in service programmes, exchange of science teachers, assistance to Associations, Science Consultancy Project, Science Subject Inspectors, Evaluation Procedure in Science, Experimental projects in Science, science teaching through television, Science Clubs, Science fairs, Science talent search, establishment of a Department of Science Education, supply of science teachers—short term course for science teachers. (Ibid., pp. 109-114) Four Regional Colleges of Education were conceived to train teachers for multipurpose and higher secondary schools. The Extension Service Centres also sponsored short courses, seminars and conferences to orient science teachers. A network of Science clubs were launched, financed by the Union Ministry of Education. To meet the shortage of equipment to teach science in Training Colleges and Training Schools, Government of India requested UNESCO assistance for the improvement of Science and Mathematics education at the secondary level under Secondary School Science Teaching Project. (SSST Project) The first order for equipment under SST Project was placed in 1962, which started under the UNDP technical assistance. The report on 'Factual Position of Science Teaching in Indian Schools (1962), visualising that the varieties of structure had certain implications as far as the depth and manner of science teaching in schools is concerned, observed that "generally the manner in which science is presented to depth to which it is taught is determined by the stage to which it applies." (NCERT, 1962, p. 34)

Viewed from this angle the observations of Sampurnanand Committe on Emotional Integration on the difficulties created by non-uniformity in school structure were significant. Noting that at the elementary stage there were schools with seven years' courses and also eight years' courses, that the age of admission to class one was five in some States and six in many others and that the duration of secondary stage varied from two years to four years, the Sampurnanand Committee recommended that:

> We consider that in the overall interest of our student population to whom education, apart from its training for citizenship, is also means to gainful employment, there should be a common pattern of education in the country which will minimise the present confusion and coordinate and maintain standards. (Quoted in the Report of Indian Parliamentary Scientific Committee, 1964, p. 22)

Though Sampurnanand Committee was concerned with problems of emotional integration but it touched upon educational aspects too. It commented on implementation of educational policies and their formulation and argued in favour of the need of a common pattern of education. The difficulties created by a variety of patterns of schooling were cited by different commissions and committees from time to time and suggested measures for reorganisation of a national pattern of secondary education. The prevalent school stages at the time of the First Indian Education Commission (1882) were lower primary, upper primary, secondary and higher secondary. Ten years of schooling was the norm to qualify for the university entrance by and large. The Calcutta University Commission (1917-19) recommended the 12 years of schooling to qualify for university entrance. The Sapru Committee (1934) suggested 11 years of schooling to qualify for the university entrance—school stages being primary of five years, lower secondary of three years and higher secondary of three years duration. The Sargent Plan (1944) recommended Primary Education (Junior Basic) of five years duration, Post-Primary Education (Senior Basic or Middle School) of three years duration and High School of six years duration including one year of the Intermediate class. The University Education Commission (1948) recommended twelve years of schooling again to qualify for university—entrance. The Secondary Education Commission (1954), finding a wide variation with regard to different stages of education; types of institutions and duration; different type of nomenclatures, suggested the eleven years of schooling as the national pattern of education visualising seven to eight years of integrated elementary, three to four years of secondary and higher secondary. This too did not give clearcut guidelines about duration of education and stages of education. The Chairman CABE (1955), perhaps, rightly observed that:

> Unfortunately, even the Secondary Education Commission did not give a clear lead in this matter. This had made it difficult to correlate secondary education with the universities and to ensure that there will be a uniformity of pattern at the secondary and higher secondary levels throughout the country. (Proceedings of the Twenty-Second Meeting, Jan. 1955)

The Indian Parliamentary and Scientific Committee (IPSC)

One of the significant developments from the point of view of

Policy Planning in education was the formation of the Indian Parliamentary and Scientific Committee, in August, 1961 with the purpose of bringing together parliamentarians' the makers of policies—scientists, advisors and implementers of policies on a platform for discussion and exchange of ideas. The Indian Parliamentary and Scientific Committee, formed a study group to examine the problem of 'Science Education in Schools' and to find out the position and methods of organisations of Science courses in primary, middle and high/higher secondary schools in relation to policies and decisions arrived at the Centre and the States for improving science teaching in our schools during the Third Five Year Plan. Appreciating the school science education as the foundation for the training of scientist and technologists, medical and agricultural experts at all levels, which were needed in much larger numbers for development and progress in all sectors such as industry, agriculture, education and other sectors of the country, the Committee considered it basic "the way in which the nation's children were educated and the society is able to transmit from one generation to the next the values, skills and knowledge which ensure its survival." (Report—(IPSC), 1964, p. 9)

The IPSC pointed out that all education and training was not only for the purpose of transmitting our traditional values, skills and knowledge to the next generation but also for building up a base of responsible citizens and for trained manpower so that requirements in terms of human resources for developing the economy could be assessed from time to time and suitable programmes of education and training institutions, modifying and improving them in relation to the requirements of our economy as it develops in future.

Analysing the objectives of science teaching and content of school science, the Indian Parlimentary and Scientific Committee (IPSC) observed that "during the last 25 years, objectives of science teaching . . . have changed little, while changes in the nature of science that ought to be taught have greatly changed . . . there is gulf between that is being taught and what ought to be taught, (Report p. 15)

Reviewing the criticism of science teaching that 'the subject of science is made mechanical and routine' and that 'the approach to understanding of science as a search for order in nature seems to be missing in the school curriculum', the committee pointed out:

> Science means collection of facts and observations preferably in quantitative terms, the construction of a hypothesis to explain the relation of facts to each other and the selection of further appropriate observation for the carrying out of experiments designed to test the correctness of hypothesis. Moreover, the scientific approach is based on the assumption that the universe is a systematic and ordered place and that every observation, no matter how unexpected, is capable of being fitted into a rational hypothesis. This approach has to be properly integrated into the curricular content of our schools to save the syllabus from being mechanistic and dull. (Report, page, 16)

From this view point it appeared to the Committee that, "reorganisation of science courses would imply that the student should acquire a useful command of science concepts and principles and he has to be as much familiar with the language of science or its vocabulary just as he knows the vocabulary of the classics, history and the creative purposes of literature." (Report, p. 16) Thus within a decade it appears that the view point expressed by the University Education Commission (1948) regarding teaching of science started gaining ground. But much of it later.

While reviewing the existing position, the Committee found the pace of progress regarding intense cultivation of science on a large scale and its application to meet a country's requirement slow, the Committee listed the difficulties that were mentioned to them viz.

1. Difficulties created by structural changes in secondary education;

2. Improvement of curriculum and syllabus of science subjects including Mathematics at the different school stages;
3. Difficulties in securing science teachers;
4. Difficulties of adequate laboratory equipment and apparatus;
5. Lack of suitable textbooks in different scientific subject;
6. Early specialization. (Report, p. 20)

The IPSC deliberated upon these difficulties one by one and suggested measures which could help to overcome them.

As already pointed out the variation of structure had certain implications for the improvement of science teaching at school stage. The Committee held that the whole question of introduction of science courses at different levels of schooling was linked with structure of school education. This relation appeared to be of special significance in respect of the projects for improvement undertaken by the centre for states.

Analysing the patterns of science teaching in schools, the Committee found variations in the depth of the content, time allotment, and was led to realise the need of "a uniformity of syllabus and science content in the course as early as possible." (Ibid., p. 36) Pointing out the earlier efforts of AICSE, the Committee felt that the purpose of a uniform draft syllabus did not serve for all States of Union, particularly Southern States which appointed their own committees for reorganisation and recommended different patterns of syllabi. The Parliamentary Committee recommended that, "there should be uniformity of courses and class structure in all the States so that the Textbooks could be written in the same way for all the States particularly in the science subjects and lakhs of copies in different languages could be made available covering uniform syllabus. (Report, p. 24)

The IPSC was sure that "unless structure is uniform, stages at which science courses should be introduced, with the gradually rising content of knowledge and practical experiments, cannot be easily visualised to all parts of the country." (Ibid, p. 23) Besides the uniformity of courses, the Parliamentary Committee suggested that . . . "some modernisation in school science curriculum has to be brought in on the basis of courses introduced in some of the advanced countries such as, the U.K., U.S.A. U.S.S.R., France, Germany and Japan." (Report, p. 24) Noting that modernisation of curriculum was a complicated problem because of reasons such as tension between the pull of the past and the urge for the future, domination of tradition and hesitation in accepting the ideal of progressive position thought of by the experts, the IPSC drew attention to some Indian documents and to some foreign documents as well. Amongst the foreign documents, the Committee commended the 'Crowther Report of the Central Advisory Council for Education, England, Volume I (1962), '59th Yearbook of the National Society for the Study of Education' (N.S.E.). 'Programme to Improve Science Teaching' published by office of Education, U.S.A.—which according to the Committee provided 'useful suggestions' for establishing cooperation between States and the Centre, and U.K. Ministry of Educations' publication on 'Science in Primary Schools' (1961) and 'Science in Secondary Schools' (1960).

Apart from the documents, the Parliamentary Committee recognised the need for emphasis on science teaching in the schools in modern times particularly in an age of scientific and technological development. It was cognizent of the fact that in all advanced countries courses of studies at the school level emphasised science as a major human activity, as a means to discover truth about nature and realised that "basic values in modern life are a deep concern of Scientific Education." (Report, p. 45) As pointed out by the Committee:

> our real approach in emphasising science teaching at this stage is how it has been explained . . . by Bertrand Russel in a statement that science today holds the same position in

> our culture as the classics held in the medieval and pre-industrial revolution period in Europe. A classics man was considered to be a well-educated person in earlier times. In modern times a man with the knowledge of mathematics, physics, chemistry, biology, etc., might be known as an educated person. (Report, p. 48)

However, with such a perception of an educated person and a predisposition to bring about modernisation in school curriculum on the basis of courses introduced in advanced countries, the Committee while analysing the position of early specialization reviewed the pattern of science teaching in U.K. and saw its implications for India to be "that courses in Arts and Science should not be divided upto the X class," and that "Specialization should be postponed as far as possible." (Report p. 30) At the same time, the Committee commended the pattern of Science education in U.S.S.R., where "all students whether they take up science courses or other courses later are compulsorily asked to study a considerable amount of mathematics, physics and mechanics . . . from the age 7 to 18" which covered "such topics as atomic structure, artificial radioactivity, energy released in nuclear reactions, cosmic rays, nuclear power stations, use of radioactive isotopes in agricultural industry and so on." (Report, p. 30)

It appears that the Committee could not clearly work out specialization in teaching of science as Physics, Chemistry and Biology and that too at what stage. On the one hand it was in the favour of "postponing the specilisation as far as possible and on the other hand, it appears, it had soft corner of the pattern prevalent in U.S.S,R. That is why, it seems, it left the matter to "those who have to formulate curriculum structure and detailed syllabus for the school classes." (Ibid., p. 30) It thus gave a large latitude and flexibility to the implimenters of the policy as well as curriculum planner to interpret its recommendation. It may be noted that our policy planners appeared to be very ambitious in recommending various measures for improvement in Science education keeping in view the position of science teaching in developed countries, which because of the difficulties already mentioned to them could not be implimented.

However, apart from making recommendations for setting up of an organisation, periodical conferences, it gave high priority for financial provisions for science education at the primary, middle and higher secondary stage. Science education in the primary schools was recommended by the Committee to be introduced in the form of 'nature study.' Not less than twenty-five percent of the lessons in different language readers were to be devoted to science subjects in form of stories, explaining the phenomena in nature as well as the lives of great scientists who have contributed to the making of the modern world. (Report, p. 46) The IPSC recommended to set up Committee like the one in U.K. to study the syllabus for "Science in Primary Schools' and to submit a report to all States for their consideration and acceptance with any modification." (Ibid, p. 46)

For the middle stage, the IPSC emphasised on genral knowledge and the proportion of time to be given to "subjects like mathematics, geography, general science including physics, chemistry, biological science, etc., alongwith humanistic subjects like language (i.e., English, Hindi, Indian languages etc.) It recommended "a standard content in all the States." (Ibid, p. 47) The Committee visualized:

> There could be a variety of textbooks giving illustrations and, perhaps, simplified approaches to explain the content of the subject. But the syllabus covered should be the same in all the textbooks accepted in the different States in different languages. (p. 47)

However, it was quick to point out that:

> There has to be a broad curriculum and the teachers should have the choice to teach the subject in accordance with the local environment urban and rural, industrial, mountain, plain and sea-shore and the emphasis should be laid on methodology of science rather than covering a fixed curriculum. (Ibid, p. 47)

For the high school stage, science was recommended to be compulsory for all students, in the form of separate subjects as

Mathematics, Physics, Chemistry, Biological Science, etc., along with the other hnmanistic subjets on the pattern in which courses were "prescribed in the U. S. S. R." (Ibid, p. 47)

Thus it appears that this high powered Committee perhaps could not work out any clearcut direction which the School Science Policy could take. It also did not give any suggestion for teaching science in rural areas. It left to the teachers to teach science according to their choice as in case of advanced countries, such as U.K. or America, whereas such a possibility did not exist as in our country, as the syllabus was decided by the States and the teacher had to cover it in a specified time. Had been any freedom,even in adopting of a particular methodoloy, perhaps he could have made the choice. The Committee did quote the work done in different advanced countries but din not make specific suggestions so that teachers could get access to the neccessary equipment and instructional materials and could acquire specific training to teach science with ablity and confidence.

UNESCO Planning Mission (1964)

The UNESCO Planning Mission (1964) came under the UNDP Technical Assistance Project in India, to study the state of science and mathematics education in the country and to define the main lines of reform concerning these subjects. The Mission consisted of nine members under the leadership of S.G. Shapovalenco (USSR), six members drawn from USSR and two members from USA. The mission worked in India from December, 23, 1963 to March 10, 1964.

The Ministry of Education, Government of India expected that the recommendations of the Mission would be on the following lines:

> The objectives and tasks of Science and Mathematics education in general type of schools in India; the place of Science and Mathematics in curricula of schools; the content of Science and Mathematics education; the philosophy of preparation of syllabuses and textbooks; methods and organisation of education; teaching equipment for science education in schools; training and refresher courses for science

> teachers; development of research in Science and Mathematics education; the basic kinds of work to be completed in India before the end of the Third Five Year Plan and those to be fulfilled during the Fourth Five Year Plan so as to considerably improve Science and Mathematics education in the country which is necessary for further development of its economy. (UNESCO Planning Mission, p. v)

The experts of the UNESCO Planning Mission were offered a broad opportunity to get acquainted with the position of Science Education in the schools of Delhi/New Delhi. Later on they were divided into two teams and visited Allahabad, Lucknow, Calcutta, Bhubaneswar, Cuttack Ajmer, Bombay, Mysore and Madras from 3.1.1964 to 21.1.1964.

The position of science education in Indian Schools according to Planning Mission, was not satisfactory. The content and methods of science education did not contain the requirements needed by the scientific technical progress and by the tasks of furthering economic and cultural development of the country. (Ibid, p. 21) The nature of science education which is stipulated by various factors, the UNESCO Planning Mission observed:

> The content and methods of teaching are determined by various factors and primarily by the needs of the Society, the position of scientific knowledge and peculiarities of the development of children who study science. (Ibid, p. 3)

Regarding the status of Science Education in India, Dr. P. Kirkpatrick from U.S.A. observed:

> Formal education in the schools and colleges of India is an adaptation of the system instituted by the ruling British power in the nineteenth century. An important purpose of that system was the production of a class of English speaking clerks and white collar civil servants. The free Indian nation, desiring education for other purposes proceeded from known to the related unknown and in some procedures seems to have been unaware that alternative philosophies of education were conceivable. In the years since the coming of Indian

> independence there has been a ferment of creative thought among Indian educators, a multitude of innovations has been proposed and debated, but the tempo of real progress has been moderate, and principally for the two reasons, (a) poverty, and (b) Intertia of custom. (UNESCO Planning Mission, p. 187)

Be that as it may, according to the UNESCO Mission the tasks of furthering economic and cultural development made it necessary "to provide modern science education to our youth so as to prepare them for life, for mastering technical, agricultural, medical and other specializations which were necessary for economic and cultural progress." (Ibid, p. 21)

But the UNESCO Mission found that:

> . . . not all eight-year schools provided science education to all the children so far. In senior classes of school science and mathematics were elective subjects but were offered by not more than 20-25 per cent of pupils. The remaining number of pupils finished schools without the fundamentals of knowledge of physics, chemistry and biology. (Ibid, p. 21)

Regarding the content, methodology of teaching, teacher training and equipment, the Mission observed:

> The syllabi and textbooks used for teaching subjects in schools of many states of India require at the present time further improvements so as to be on par with the requirements of modern science and engineering. Science education is mostly carried out by verbal methods due to a considerable shortage of teaching equipment and also because many teachers have not yet mastered the methods and technique of school equipment . . . Non-availability of a great number of youth having modern science and mathematics education hinders the development of industry, agriculture and economy of the country on the whole. (Ibid, pp. 21-22)

In line with the Secondary Education Commission (1953) and later on the Sampurnanand Committee (1962) and the Report of

Factual Position of Science in Indian Schools (1962) the UNESCO Mission too lent support to the need of uniformity of a school pattern by pointing out that:

> Every state has its own period of education in schools (10,11, 12 years), its own curricula and textbooks. Even within one state, one can see a great number of types of schools providing different levels of knowledge to pupils. This creates difficulty in the preparation of high quality syllabi textbooks, guides, training of teachers in colleges and universities, introduction of new methods of teaching and unified criteria of evaluation of science education. (Ibid, p. 22)

The UNESCO Planning Mission also found that the States had different approaches to the place of science in the Curricula. In some States (West Bengal, Madras, etc.) compulsory study of Science was provided upto 10th class of secondary school. In Delhi and other States, it was taught only upto class VIII. The duration for teaching science too varied in different states. For example, the schools of Delhi gave five periods per week in each of the classes I-V, while Kerala schools gave two periods a week, in classes I and II, three periods a week in class III-IV and four periods a week in class V. Delhi schools had four periods a week science education in classes VI-VIII while in Kerala they had three periods a week in classes VI and VII and five periods a week in class VIII.

The UNESCO Mission opined that keeping in view the need for science education of the youth as determined by role of science in modern life being the same and the importance of science training of the youths for the development of the economy and culture of all the States being also the same, "the nature, content and methods of science education as well as their place in the curricula of the schools should be similar in all the states." (Ibid, p. 25)

What type of School Science education and what approach was to be adopted for Indian schools, the Mission analysed the general science syllabuses for classes I-VIII and found that it needed further improvement so as to rectify "a number of serious shortcomings" (Ibid, p. 23), in the syllabus. According to the Mission, "The main shortcoming of this syllabus consisted in the fact that instead of systematic study of the fundamentals of science about nature in the required sequence (Physics, Chemistry, and Biology) the pupils of classes VI-VIII were supplied with superficial separate knowledge of Physics, Chemistry, Biology any other sciences in connection with teaching of complex problems taken from the environment." (Ibid, p. 28) The Mission therefore opined that:

> Application of the existing approach to science syllabus for classes VI-VIII leads to inferior standards of science education of pupils in school. Thus, having studied for three years, the pupil will not acquire the systematic science education that can be considered as the only basis for understanding a great variety of phenomena of the life surrounding us, with which the pupil meet in his future life. In the century of sharp differentiation of scientific knowledge, it is hardly expedient to limit the education in classes VI-VIII by teaching certain questions of science on complex themes of the environment. (Ibid, p. 28)

Thus the UNESCO Mission was not in the favour of teaching science as 'General Science'. The Mission opined that the complex topical approach was "not useful for training pupil for work and for further education in Secondary and Higher Educational establishment." (Ibid, p. 29) The UNESCO Mission citing the experiences gained in U. S. S. R. recorded that:

> In the thirties the USSR used topical approach in teaching science which was taken from USA and Germany. But the application of this method did not ensure the training of the youth for studies in secondary and higher educational institutions and, therefore, it was replaced by systematic teaching of science from class V, which made valuable contribution in economical (time and funds) solution of the problems of training the youth capable of mastering various specializations required for people's economy. (Ibid, p. 29)

Thus taking into account the development of scientific knowledge the conditions of its teaching in Indian schools, the need of qualified cadres for the development of economy and culture and the experience of USSR the UNESCO Planning Mission recommended that "all the citizens should have modern science education so as to understand modern life, participate in the development of the economy and culture of the country." (Ibid, p. 25)

Accordingly Planning Mission recommended the teaching of Science from class I. Considering the complex nature of modern problems of science and also taking into account the fact that a certain part of the pupil's entry into professions after finishing class VIII, it suggested three stages; Stage I (Class I-V), stage II (Classes VI-VIII) and Stage III (Classes IX-XI).

At stage II, i.e., in classes VI-VIII with a view to ensuring successful comprehension of knowledge in Physics Chemistry and Biology, the Mission suggested the teaching of these subjects to go continuously and concurrently, supporting each other by subject inter-relations. The application of this scientific knowledge in production, culture, health services and every day life was also to be taught. Thus the Planning Commission recommended a major shift in teaching science at Middle stage.

The report of the UNESCO Planning Mission was considered by CABE in 1964, which found the findings of eminent Russian and American experts "useful in the future of science education." (CABE, 1964, item No. 8) All the recommendations made by Mission were approved by CABE (1964). (Appendix D). Some of the main recommendations approved by CABE were:

—A programme of Science education for all the students from class I to X and specialised programme for those offering the Science stream up to Class XI.

—General Science teaching up to class V and then separate disciplines of Biology, Physics and Chemistry from class VI onwards.

—The guiding principle of Science education be a judicious combination of theory and practical work, both demonstion and individual experimentation.

—Preparation of textbooks on certain suggested principles and translation of some Russian Textbooks. (CABE, 1964, Item No. 8)

Education Commission (1964-66)

While the recommendations of the UNESCO Planning Mission were being taken up at the Central (NCERT) level, the Government of India, by a resolution dated, 14th July, 1964, appointed the Education Commission which submitted its report on 29th June, 1966. The Government Resolution appointing the Commission pointed out that "the educational system has not generally evolved in accordance with the needs of the times, and a wide and distressing gulf continues to persist between thought and action . . . national policies and programmes concerning the quality of education, even when these are well conceived and generally agreed to, could not be implemented satisfactorily." Report, Education and National Development, Appendix II, p. XV) The Commission, under the Chairmanship of Professor D. S. Kothari, member-secretary Sri J. P. Naik and other Indian as well as foreign experts was appointed to advise the Government "on the national pattern of education and on the general principles and policies for the development of education at all stages and in all aspects," except legal and medical education (Report, 1966. p. 9) The foreign experts were from U. K., U.S.A., U.S.S.R., Japan, France and UNESSO. For twenty-one months the Commission and its Task Forces and the Working Groups on various aspects of education worked incessantly to work out a national pattern for Indian education to fulfill the need for "a drastic reconstruction, almost a revolution in the educational system." (Ibid., p. ix) The Commission while recommending a unified approach to the framing of the entire school curriculum, suggested a common curriculum of general education for the first ten years of school education in non-vocational schools, diversification of studies and specialization only at higher secondary stage. It suggested a reduced load of formal subjects and emphasis on language, elementary mathematics and environmental studies at the lower primary stage, broadening and deepening of curriculum with systemic teaching methods and more specific standards of attainment at the primary stage and the lower secondary stage. (Ibid, pp. 391-392)

As pointed out by the Commission the existing educational system "designed to meet the needs of an imperial administration within the limitations set by a feudal and traditional society needed radical changes to meet the purposes of a modern democratic and socialistic society in objectives, in content, in teaching methods, in programmes, in the size and composition of the student body in the selection and professional preparations of teachers and in organisation." (Ibid, p. 9).

The revolution in the educational system as thought of by the Commission could be achieved through:

—internal transformation so as to relate it to the life, needs and aspirations of the nation;

—qualitative improvemnt so that the standards achieved were adequate keep continually rising, and, at least in a few sectors become inter-nationally comparable; and

—expansion of educational facilities broadly on the basis of man-power needs and with an accent on equalization of educational opportunities. (Ibid, p. 10)

The most important and urgent reform needed in education was, "to transform education, to endeavour to relate it to the life, needs and aspirations of the people and thereby to make it a powerful instrument of social, economic and cultural transformation necessary for the realization of the national goals." This, the Commission thought, could be achieved if education was related to productivity, strengthened social and national integration consolidated democracy as a form of Government and as a way of life accelerated the process of modernization, and cultivated social, moral and spiritual values. (Ibid, p. 10)

Education was to be related to productivity, so as to increase the national income which, in turn, could lead to a larger investment in education thus constituting a 'rising spiral' whose different parts would sustain and support each other. This link, the Commission thought, could be forged through high priority to educational reconstruction plans consisting of the following programmes:

—making science a basic component of education and culture:

—making work experience an integral part of general education;

—vocationalization of education, especially at the secondary school level, to meet the needs of industry, agriculture and trade; and

—improvement of scientific and technological education and research at the university stage with special emphasis on agriculture and allied sciences. (Ibid, p. 12)

The Commission gave top priority to 'making science a basic component of education and culture' because it perceived "close interlocking and interdependence between science and technology as a characteristic of the contemporary world." (Ibid. p. 12) It, therefore, recommended that, "Science education must become an integral part of school education; and ultimately to become a part of all courses at university stage also." (Ibid, p. 40)

The proper objectives and purposes of science teaching were "to promote an ever deepening understanding of basic principles, to develop problem-solving and analytical skills and the ability to apply them to the problems of the national environment and social living, and to promote the spirit of enquiry and experimentation." This alone, the Commission felt, could make "scientific outlook become part of our way of life and culture." (Ibid, p. 12)

Even work experience, defined as productive work, to be introduced as integral part of all education was suggested to be oriented to technology, industrialization and to the application of science to productive processes, including agriculture. In this context, the Education Commission (1964-66) poined that "... all good and purposeful education should consist of at least four basic elements:

(i) literacy or a study of languages, the humanities and the social sciences;

(ii) numeracy or a study of mathematics and the natural sciences;

(iii) work experience, and

(iv) social service" (Ibid, p. 13)

The commission was of the view that whereas 'most of the time was taken by the first' that is 'literacy,' as far as the second, that is 'numeracy,' was concerned it was still quite weak and needed a great deal of emphasis.' (Ibid, p. 13)

As already discussed teaching of science is related to the structure and duration of school educational system. The Education Commission suggested that " . . . for the vast majority of pupils there would be a single curricular stream from class I to class X, ending with the first external or public examination, and there would be no 'streaming' or specialization in this general course." (Ibid., p. 324) For this duration of schooling upto ten years, even though, the earlier committees and Commissions recommended uniformity in the pattern of schooling, the Education Commission suggested flexibility in organisation of educational structure.

It recommended seven or eight years for primary stage, three or two years for lower secondary stage. However, out of the four identifiable elements; (a) the structure of the division of the educational pyramid into different levels or stages and their inter-relationships, (b) the duration or total period covered by different stages; (c) the quality of teachers, curricula, methods of teaching and evaluation, equipment and buildings, and

(d) the utilization of available facilities, the first element received less attention.

Amongst a few were Singh (1973) who pointed out that, "the Education Commission has adopted a democratic attitude towards the organisation of educational structure and recommended a flexible formula. It shows its lack of faith in complete structural uniformity in a vast country. It proposes to give the general practitioner in education a good deal of choice." (Secondary Education and the Education Commission, p. 120) But not much of such a choice could be made out simply because state level functionaries, bogged down by inertia, let the states of matter continue as they were.

Be that as it may, aim of science teaching in the lower primary classes was recommended to be "to develop proper understanding of the main facts, concepts, principles and processes in the physical and biological environment." (Education Commission Report, p. 344) Deductive and inductive approaches were suggested to be utilized to unravel these ideas, though more emphasis was suggested to be laid on "the deductive approach or the use of the scientific method." (Ibid., p. 344) Keeping in focus the child's environment—social, physical and biological, the Education Commission suggested an accent on cleanliness, formation of healthy habits and development of the power of observation in classes I and II. In classes III and IV, study of the environment (covering science and social studies) was suggested, which ought to include personal hygiene and sanitation, formal areas of science such as, plants, animals in the surroundings, air, water, weather, earth, heavenly bodies, simple machines, school gardening etc. These areas were perceived to provide pupils "with direct and valuable experiences of natural phenomena." (Ibid, p. 344)

At the higher primary stage the emphasis was shifted "to the acquisition of knowledge together with the ability to think logically, to draw conclusions and to make decisions at a higher level." (Ibid, p. 344) Science was to be taught as Physics, Chemistry, Biology, Geology and Astronomy. The suggested allocation for these subjects among the three classes was:

Class V—Physics, Geology, Biology

Class VI—Physics, Chemistry, Biology

Class VII—Physics, Biology, Chemistry, Astronomy

Even though the Education Commission recommended that "other combinations may be tried depending upon the level of the students and local conditions," (Ibid, p. 344) regarding the earlier general science approach to the teaching of science which was widely adopted, it concluded that the general science approach did not prove successful as "it tends to make science appear somewhat formless and without structure and runs counter to its methodology." (Ibid., p. 345) A "disciplinary approach to science learning" the Commission thought would, "be more effective in providing the necessary scientific base to young people." (Ibid, p. 345)

The Education Commission thus recommended major shift in school science policy, in as much as while the general science approach recommended by National Basic Education Scheme and the Secondary Education Commission was gathering momentum after years of work, another approach—the disciplinary approach for teaching science was being recommended by Education Commission. Thus, when one set of recommendations made by earlier Committees and Commissions was being implemented another set of recommendations—a major shift in policy, was taken up for implementation. The pendulum of school science reform swung to the other side putting the school science education policy at the cross-roads again. The Commission catagorically stated that, "at the Secondary School Stage, Science as a discipline of the mind and a preparation for higher education, deserves special emphasis, In lower secondary classes Physics, Chemistry, Biology and Earth Sciences should be taught as compulsory subject for all the pupils . . . they should be made to cover wider areas and go deeper into the content than before." (Ibid, p. 345) The newer concept of Physics, Chemistry, and Biology and the experimental approach to the learning of science were to be stressed and the changing character of the sciences was also to be regarded as the major factor in curriculum development. (Ibid, p. 345)

In secondary schools in the rural areas, the linking of education to the agricultural environment was recommended to be "done through integrated courses" to bring out the impact of the Physical Science on Biology. In view of the need to apply science and technology to Indian agriculture, it was thought desirable "to introduce gradually the pupils in rural secondary schools to the ideas and practices of scientific farming and the activities and skills related to it." (Ibid, p. 346) Similarly, in urban industrialized area schools, the curricula was to be oriented "towards the technical and industrial aspects of experimental science and its impact on industrialization." (Ibid, p. 346)

However, the debate of having same curricula for rural and urban schools persisted. Even though the Education Commission had in mind two different curricula in science for rural and urban secondary schools, yet it was quick to recommend that "the levels to be attained in the rural and urban schools should be the same and avenues to higher education schould be available to students from both types of schools without discrimination." (Ibid, p. 346) Inspite of the fact that similar experiments in science curriculum for rural and urban schools were made during British period as well as later after independence and such experiments did not succeed, perhaps because, among other things, people did not welcome different types of courses for their children. Yet the Commission appears to have made this recommendation perhaps to placate different lobbies.

Going through the report, of Education Commission, report of the task force on Science Education, School Curriculum, big list of members and consultants, it appears that Commission, regarding school science education policy tried to arrive at a compromise amongst progressive education view point, structure of Discipline Movement and individual discipline (subject) approach and left the details to Central and State level administrators. This attitude, perhaps, helped decision makers to interpret the recommendations, in their own manner, according to their own convenience.

As mentioned already, CABE (1964) had already approved the recommendations of UNESCO Planning Mission (Appendix D) the discipline-approach of teaching school science. This was again recommended by Education Commission. The implementation of this recommendation of the Mission had already started in 1964 by NCERT under a project called Secondary School Science Teaching Project (SSST). The major work done according to the recommendations of UNESCO Planning Mission, Education Commission and Committees will be discussed in the next chapter. However, it would be suffice to note that during the period under review there appeared a major shift in school science education policy.

Review

Looking back, the period under review 1962-67 appears to be a watershed as far as the school science education policy is concerned. Even though, just after independence the elitists advocated a concept oriented approach towars the teaching of school science as early as 1948, University Education Commission) the so-called progressive educationist's idea of teaching school science according to general science approach held sway. The factual survey 'Position of Science Teaching in Schools' (1962) conducted by DEPSE found science was being taught in a variety of forms as general science at primary level but it was alternated with Music, Home Science and Drawing at middle level and was provided both under the core curriculum as well as under the elective programme at the secondary level. The Indian Parliamentary Science Committee (IPSC) (1964) agreed with the DEPSE's factual survey that science teaching at school stage was not satisfactory. It thought that this was dueto a lack of common pattern of education, differences in educational standards, and lack of coordination between Centre and States. Noting that 'during the last twentyfive years objectives of school science teaching changed little, while changes in the nature of science that ought to be taught have greatly changed,' the IPSC not only recommended that there ought to be 'uniformity of courses and class structure in all the States, but it also recommended the upgrading of the content of science so as to bring it at par with the courses in advanced countries such as, U.K., U.S.A., U.S.S.R., France, Germany and Japan. Not only this, the IPSC also stressed the need for preparing instructional materials in science on the lines of material prepared by Physical Science Study Committee (PSSC) of U.S.A. and to have similar books for all the stages. It appears that IPSC could not give clearcut directions to implementors, as on one hand it suggested postponing the specialization as far as possible and on the other hand commended the pattern 'prevalent in U.S.S.R.' Thus it gave latitude and flexibility for the decision makers who could interpret their recommendations in any way they found convenient.

The UNESCO Planning Mission (1964), after a critical study of the syllabi, equipment, teacher's competence as well as the needs of the country to provide skilled and semi-skilled workers for agriculture, heavy and machine making industries found general science—the complex topical approach 'not useful for training pupil to meet the country's needs as well as for further education in secondary and higher educational establishment.' The factors, attributed to the unsatisfactory state of science teaching in schools were the legacy of a system "instituted by the ruling British Power", "poverty" and inertia of the custom". On the basis of the USSR experience, the Mission recommended a programme of science education for all the students from class I to X. It recommended teaching of General Science upto class V and the teaching of separate disciplines of Biology, Physics and Chemistry from class VI onwards. CABE (1964) found the recommendations of UNESCO Planning Mission, which included Russian and American experts useful for the future of science education in

India and based on these recommendations a pilot project, Secondary School Science Teaching (SSST) was taken up at national level (NCERT) during the year 1964-65.

The Education Commission (1964-66) identifying the need of a revolution in the educational system through internal transformation by relating it, to the life needs and aspiration of the nation, by achieving qualitative improvements by expanding educational facilities and by relating education to productivity recommended science as an integral part of education. Science teaching was 'to promote an ever deeping understanding of basic principles to develop problem-solving and analytical skills and to inculcate ability to apply them to the problems of the natural environment and social living, and to promote the spirit of enquiry and experimentation'. It found general science approach of teaching science not suited to the country's emerging need. It argued that general science did not prove successful as it was somewhat form less and without a structure. For science learning to be 'more effective in providing the necessary scientific base to young people', it suggested the disciplinary approach. It, not only, reaffirmed the recommendations of the UNESCO Planning Mission but went further while recommending teaching of science as individual subjects of study as early as from class V onward. It recommended the teaching of Physics, Geology, Biology in Class V, the teaching of Physics, Chemistry, Biology in Class VI and the teaching of Physics, Biology, Chemistry, Astronomy in class VII, contrary to the recommendations of Secondary Education Commission and IPSC which thought the middle stage was not a stage for specialization. However, the Commission also recommended other combinations to be tried depending upon the level of the students and local conditions thus providing an escape to decision makers and placating the different lobbies. As it were, it appears, it provided an opportunity to decision makers to maintain the status quo or to do in any way they found it convenient.

The recommendations of Education Commission (1964-66) heralded a major shift in the School Science Policy that from a General Science approach to Structure of Discipline approach. How far this was due to elitist's pressure and how far it went against the national aspirations of popularizing science amongst masses, can only be assessed in future, as pointed out by Sir John Adams in Evolution of Educational Theory' that "the present is the darkest moment in the History. It is only when it is dead and gone that some thing can be made out of it." However, even though, the Education Commission gave a new direction for school science education policy, yet by allowing various combinations to be tried out and also suggesting different curricula for rural and urban schools it did leave its directions sufficiently vague so as to be interpreted by the decision makers in a manner convenient to them.

REFERENCES

Adams, John, 1919, *Evolution of Educational Theory*. London: London Universi.y Press.

CABE, 1955, *Proceedings of the Twenty Second Meeting January, 1955*. New Delhi: Ministry of Education, Government of India.

Committee on Emotional Integration, in (*Indian Parliamentary and Scientific Committee, 1964*).

CABE, 1964, *Proceedings of the Thirtyfirst Meeting*, New Delhi: Ministry of Education, Government of India.

DEPSE, 1962, Science Education in the Regional Training Colleges. *Report of the Working Group*, New Delhi: NCERT (DEPSE).

Education Commission (1964-66), 1966, *Education and National Development*. New Delhi: Ministry of Education, Govt. of India, NCERT. Reprint Edition, 1971.

Indian Parliamentary and Scientific Committee, 1964, *Science Education in Schools*. New Delhi: Ministry of Information and Broadcasting (Govt. of India) Reprint, NCERT, 1965.

Mahalanobis, P.C. 1962, The Scientific Base of Economic Development, in *NCERT, 1962*).

NCERT, 1962, *Position of Science Teaching in Indian Schools—A Factual Report*, New Delhi: NCERT.

NCERT, 1973, *The Fourth Indian Year Book of Education, Secondary Education.* New Delhi: NCERT.

Singh, R.P. 1973, Secondary Education and the Education Commission (1964-66) in (*NCERT, 1973*).

UNESCO Planning Mission (1964), 1965, *Science ane Mathematics Education in Indian Schools.* New Delhi: NCERT.

Blackett, P.M.S. 1963, 'Government, Scientiffc and Technical Development in Emerging Countries' in (*School Science Vol. II, No. 1*, 1963, pp. 27-31)

Committee on Plan Projects. 1964, *Report on Science Education in Secondary Schools.* New Delhi: Committee on Plan Projects (Government of India)

Committee of Members of Parliament on Education (1967). *Report* (National Policy on Education). New Delhi: Ministry of Education. (Government of India).

CABE, *The Proceedings of the Meeting of the CABE, January, 1962, May, 1963, October, 1964, October, 1965.* August, 1967. New Delhi: Ministry of Education (Govt. of India).

Education Commission, 1965, *Discussion Paper on Major* Problems of Secondary Education. New Delhi: Education Commission Government of India (Reconstruction of Curriculum—pp. 26-30)

Education Commission, 1965, *Questionnaire.* New Delhi: Ministry of Education. (Government of India).

Education Commission's Working Group on Curriculum, 1965 Report for the Indian Education Commission. New Delhi: NCERT. (Professor B. Gosh, Convenor).

Ministry of Education, *Education in India* (*Annual Reports*) *1962-63, 1963-64, 1964-65, 1965-66, 1966-67.* New Delhi: Ministry of Education (Government of India).

Ministry of Education, Conferences of Education Ministers, (April, 1964), (June, 1966), (April, 1967) in Biswas, A. and Agrawal, Suren (Ed.). *Indian Education—Documents Since Independence.* New Delhi: The Academic Publishers India.

NCERT, Annual Report, *1963-64, 1964-65, 1955-66, 1966-67, 1967-68,* New Delhi: NCERT.

National Academy of Sciences—National Research Council, 1963, *Guidelines for Development of Programmes in Science Instruction.*

Washington National Academy of Sciences—National Research Council.

Punjab Education Department, Chandigarh, 1966, *Sample Question Paper in General Science for Middle Standard Examinations.* Chandigarh: Assistant Director, Examinations, Punjab Education Department.

Planning Commission (Education Division) 1965, *Proceedings of the Conference of State Education Ministers.* New Delhi: Planning Commission (Government of India).

Yantsov, A. I. 1963, 'Achievements of Modern Science and Technology in the Soviet School's in *School Science Vol. II, No. I*, pp. 87-91).

Wanchoo, V. N. 1965, *Mathematics and Science Education in Indian Schools*, Delhi: All India Science Teachers Association.

9

SCHOOL SCIENCE EDUCATION DURING 1967-72

> Science education at the pre-college level in modern India is an intriguing blend of much of the best and some of the worst science teaching from all over the world. American teaching methods can be seen being applied to a basically British curriculum 'using Russian built equipment. In another area, a Russian style programme is taught by teachers trained in British fashion, using equipment developed with American help. American, British and Russian textbooks and library books are used indiscriminately. The objectives of teaching science have also been borrowed from a variety of sources. (Educators, 1971, p. xiv)

If the period 1962-67 was the period of decision making in school science education policy, the period 1967-72 may be identified as the period of working out implementation strategies for those decisions. Due to an economic recession that set in as a result of two consecutive years of drought, annual plans were prepared and implemented during the years 1966-67, 1967-68 and 1968-69, (Ministry of Education, 1968, p. 2)

These Annual Plans by and large made provision for continuation of educational policies and priorities of the Third Five Year Plan. However, one of the significant event was the appointment of a Committee of Members of Parliament on Education, by the Government of India in April, 1967 consisting leading members of all the different political parties in the country to evolve a national policy on education. The Committee was to consider the report of the Education Commission (1964-66), to prepare the draft of a statement on the National Policy on Education for the consideration of the Government of of India, and to identify a programme for immediate action. In its draft on National Policy on Education, the Committee recommended Science and Mathematics as an integral part of general education till the end of class X and emphasised improvement in the quality of science teching at all stages. Considering the needs of equalisation of educational opportunity the Committee suggested a broadly uniform education structure for all parts of the country and a common pattern of general education for all children reaching a standard equal to the then existing Secondry School Leaving Certificate examination—the Ten year School, The Committee felt an urgent need to upgrade and improve school curricula, to increase the knowledge-content of these and to provide adequately for the development of skills and the inculcation of right interests, attitudes and values. The Committee also touched upon the quality of textbooks and recommended that, it is essential that an increasing number of common books should be read by all school students in the country." (Report p. 14)

The report of the Committee of Members of Parliament on Education (1967) and the proceedings of the Conference of Education Ministers (1967) were considered in the CABE's Thirty third Meeting (1967).

The Government of India on the recommendations of these various committees declared the National Policy on Education in 1968 which directed for "a sustained and intensive effort to raise the quality of education atall stages, an emphasis on the development of science and technology", (Resolution, 1968, par. 3) The sustained and intensive effort to raise the quality of education particularly science and technology education were necessary if the country was "to attain its rightful place in the cultural heritage and its unique potentialities." (Ibid, par. 3)

With a view to accelerating the growth of the national prosperity science education was to receive high priority. Science and Mathematics, both were recommended an integral part of general education till the end of the school stage. The reconstruction of education on the lines needed an addition outlay. So it was intended to gradually "increase the investment in education so as to reach a level of expenditure of six per cent of the national income as early as possible." (Ibid, par. 4) Keeping in view the key role of education, science and research, in developing the material and human resources of the country, the National Policy on Education directed that the centre in addition to undertaking programmes in the Central Sector, would assist the State Governments for the development of programmes of national importance where coordinated action on the part of the States and the Centre was called for. (Ibid, par. 17) The Government of India was also "to review every five years the progress made and recommend guidelines for future developments.', (Ibid, par. 17)

In the Thirty-fourth Metting of CABE held on October, 11-12, 1968, the revised Fourth Five Year Plan in Education was discussed. The Union Minister of Education expressed the need to select six national programme for intensive implementation out of these six national programmes accepted for intensive implementation over the next five years, Science education ranked fourth in the list. (Proceedings of the CABE's thirty-fourth Meeting, 1968) The CABE approved the proposals made by the Planning Group observing that "Science education with special emphasis on the development of scientific attitudes and skills should be given the high priority." (Planning Commission, 1968). While reviewing the position of School Science Education, the Planning Group on Education, (1968) found that considerable expansion in school science education facilities took place in the First Two Plans. In the Third Plan the steps which were taken to effect qualitative improvement in the teaching of school science, just touched a fringe of the problem. The Planning Group, therefore, felt the need for giving a high priority to the programmes of science education as the country needed more and more people who would be able to provide necessary technical man power needed for heavy and machine making industries already established in the country and could use the scientific method in solving their problems. Noting that at the primary stage science in some form or the other was taught in all the States of the Indian Union, the Planning Group found that the physical facilities, the quality f programmes, and the teacher competences were far from satisfactory with the result that science was mostly taught through reading activity as any other non-science subject and hardly contributed anything towards bringing about the desired attitudinal changes. (Ibid, p. 145.)

At the middle stage, the Planning Group found that though science was prescribed as a compulsory subject in all the States, but in actual practice many of the schools where the necessary facilities of teaching science were not available and were allowed to offer other subjects in lieu of science as an optional subject. In some States it was possible for a student to pass the middle stage without studying any science at all. Very few trained science teachers, with requisite minimum qualifications, were available to teach in the middle schools. The position of science equipment and physical facilities were eually bad in as much as only a few schools had a separate science room at this stage of school education. (Ibid, pp. 145-146)

At the primary and middle stages, the Planning Group (1968) found that science experiences were organised through a course of general science in all the States. Though during the recent years some of the states had revised their general science syllabus with a view to modernise and upgrade the content of science, the Planning Group found the textbooks far from satisfactory both in content and method of presentation. There were practically no teacher guide materials available for the help of teachers. Noting that at the high/higher secondary stage, though the subject of general science was compulsory for all the students, in some States it was possible for students to pass the high school/higher secondary examination without any science at high/higher secondary stage. At this stage about 8,000 secondary schools were without any science laboratory. At the senior secondary stage most of the science syllabi were outdated and provided very little practical work. Wherever a provision for such practical work existed, it was mostlyo f a verificational type, hardly contributing anything towards arousing the curiosity of the child and nurturing his creativity. (Ibid, p. 146)

Out of a total of 64,981 teachers who were teaching science in secondary schools, the Planning Group found that only 65.1 per cent possessed the minimum qualification of a Bachelor's degree. The number of trained science graduate teachers was even less. Even at the senior secondary stage, intermediates and matriculates who had no science education were also teaching the subject. The shortage of postgraduate science teachers for the higher secondary sections was acute. There were about 5,500 post graduates with science qualifications teaching at the higher secondary level out of which fifty per cent possessed the training qualifications. Thus on an average, less than one postgraduate teacher was available for each higher secondary school against the minimum requirements of about 2.5 teachers. (Ibid, p. 146)

Very little attention was paid to the out of school science activities. The Planning Group found that only about 5 per cent of the existing senior secondary schools had a science club in some form or the other. The activities—the clubs were mostly of collection, classification and model making type. Though active efforts were made to build infrastructure for improvement of science education in States (cent per cent Central grant), only thirteen States were able to set up a State Institute of Science Education or the Science Unit, which were yet to develop fully to undertake the tasks for improvement of school science.

Realising the importance of Science and taking into account the existing position of science education in the country, the Planning Group proposed the following steps to improve school science education in the revised Fourth Plan commencing from 1969.

1. Strengthening of existing 1,400 teacher training schools with laboratory and workshop equipment.
2. Provision of Science Kits to 21,000 primay schools,
3. In-service training of 21,000 primary school teachers of selected schools.
4. Provision of mobile laboratory-cum-training vans.
5. Establishing 150 Science training centres in selected science colleges.
6. In-service training programme for existing teachers of science and mathematics working in middle schools.
7. Provision of a science study-room and equipment for senior elementary schools.
8. Strengthening of State Institutes of Science Education.
9. Science Units in the Directorate of Education.
10. Science Supervisors in the Districts.
11. Pre-service training of science teachers.
12. Construction of additional laboratories.
13. Supply of equipment to new and existing instiutions.
14. Provision of laboratories, equipment for elective courses in science in 12-year schools.
15. Provision of science equipment for the laboratories of the existing teacher training colleges.
16. In-service training programme for secondary school teachers.
17. Out-of-class science activities.
    (a) Establishment of Science Clubs in Secondary Schools.
    (b) Organisation of Science Fairs at various levels.

(c) Training courses for science club sponsors.

(d) Establishment of State Science Museums.

(Planning Commission. 1968, pp. 147-148)

Thus it may, reasonably be concluded that school science education was accorded a high priority in the planning.

Fourth Five Year Plan (1969-74)

The Fourth Five Year Plan aimed at acceleration of the tempo of development. (Fourth Five Year Plan, 1969-74, pp. 12-13) The Plan reiterated that "reforms in the educational system should help the growth of initiative and enterprise, make for horizontal and vertical mobility, open up wider opportunities for employment and enable the lowering of caste, class and regional barriers so that a purposeful change towards an egaliterian society can be brought about." (Ibid, p. 28) The Plan realized that "a suitably oriented system of education can facilitate and promote social change and contribute to economic growth, not only by training skilled man-power for specific tasks of development but by creating the requisite attitudes and climate." (Ibid, p. 278) Importance was given to expansion and improvement of science education and teachers' training, to reduce the backlog of untrained teachers. The main effort in the Fourth Plan was to enrich the content and improve the quality of secondary education. Educational proposals proposed in the Fourth Five Your Plan needed "Rs. 1500-1600 crores." The Chairman (CABE) estimated that the minimum amount needed for the inevitable expansion alone was about Rs. 1100 crores. Accordingly a provision of Rs. 1500 crores as being absolutely essential to achieve the minimum targets of enrolment and to maintain minimum standards in quality was suggested. But the education outlay came dome to Rs. 829 crores, taking into account the states and the centre together, and this was the lowest allocation in terms of percentage of the total plan outlay ever since Planning began in this country. (CABE, 1970, p. 105) The best course as suggested by Chairman, CABE was to take up the most essential programmes. This in effect meant utilization of major portions of allocations for the on-going programmes.

Apart from continuation of cent per-cent Central assistance to States for State Institute of Education, for strengthening science laboratories in secondary schools, long term condensed courses and short-term refresher courses for science teachers and grants for State Units for Science Education/State Institutes of Science Education, as a sequel to the recommendations of Education Commission (1964-66) twentyone study groups were set up to develop a total curriculum for Secondary School stage for a course of compulsory science. Again, with UNESCO's assistance, under Science Education Project five hundred and fifty training institutions and eleven hundred schools were equipped with necessary equipment for science teaching.

The CABE (1970) in its Thirty Fifth Meeting cxpressed its concern for proper implementation of the National Education Policy. For the slow progress in its implementation it was argued that Centre has no authority over education, which is mostly a state subject, the centre can indirectly influence educational policies of states provided it is in a position to give substantial financial aid; this is possible only through a large centrally sponsored sector. But unfortunately the Central sponsored sector in education has been immensely reduced in the Fourth Five Year Plan." (CABE, 1970, p. 53) The CABE (1970), therefore, suggested collection of relevant information from the states and Union Territories regarding the extent to which it was possible to implement the National Policy on Education and desired a consolidated review for the country as a whole.

Science Education at School Stage

As mentioned earlier, science at the primary school stage was being taught according to the general science approach, even though the Education Commission advocated a new concept of teaching science based on both "deductive and inductive approaches" . . . while at the same time suggesting that "more emphasis may be laid on deductive approach" (Report, p. 344) Work done under various programmes of teaching science at primary level in various states indicated that general science approach still continued as an accepted trend. However, at the middle and secondary stage the NCERT took up programmes such as, Textbook Improvement Programme, Panels and Editorial Boards, Study Groups, Secondary School Sceince Teaching Project (UNESCO-UNICEF assisted programme) Pilot project had already been conducted while school science education policy was being deliberated upon by the Education Commission. As the policy lines laid by the Commission were in consonance with the approach taken up in these pilot projects. major efforts were mounted to take up these as projects under implementation programmes during 1967-72.

The UNESCO Secondary School Teaching Project in India was initiated in December, 1962. The Project was started under the then UNDP Technical Assistance Programme and was later projected into the Indian National Programme for the development of education during the Fourth and Fifth Five Year Plans. Before the start of the actual project activities, the UNESCO Planning Mission (1964) visited India to study the state of science and mathematics education in India, and defined the main lines of reform concerning these subjects which have already been discussed.

The suggestions made by the Planning Mission together with the policy decision of the Education Commission (1964-66) and subsequently, the Plan of Operation drawn up by the UNESCO staff mission in 1966, formed the guidelines for evolution of the project work. The National Council of Educational Research and Training (NCERT), New Delhi, was designated the responsible body by the Union Ministry of Education and Social Welfare, Government of India for implementing the Project objectives. The Department of Science Education (DSE) of the National Institute of Education (NIE) at the NCERT was selected as the location of the Project.

During the various phases of its implementation, the pilot project received help and guidance from UNESCO Headquarters. The Chief of UNESCO Mission in India and the UNDP Resident Representative personally and together with their staff rendered assistance in the execution of the project. The project was one of the few which UNDP continued its association over a long period of time. The preparatory phase covered mainly the period from 1964-1967. During this phase the syllabi in Physics, Chemistry, Biology and Mathematics for middle classes 6-7-8, the experimental teaching materials in Physics, Chemistry, Biology. and Mathematics were prepared. These teaching materials included syllabi, curriculum guides, textbooks, and teachers' guides. A number of items of demonstrational apparatus were also prepared for experimental teaching and for training of teaching materials teachers of the experimental schools. Special laboratory furniture was manufactured to equip the science rooms in the experimental schools. (Brioukhanov, 1967, pp. 7-22)

At the first phase, the exprimental teaching materials were tried out in thirty experimental schools in Delhi under close observation by the UNESCO-NCERT experts. An extensive scheme of supervision and teacher-training was developed with the idea of helping teachers to understand new methods of teaching and, in turn, receive the feedback information from the schools. Some evaluation programmes were also carried on in schools to enlarge the flow of feedback information. The members of the UNESCO team, together with their Indian colleagues, visited other States of India to compare the teaching situation in schools. This information revealed that conditions of Delhi schools were special. The feedback from Delhi schools suggested the changes required in the approach and content of textbooks and teachers' guides, and therefore, efforts were made to take into account the conditions of other schools in general all over India. After the analysis of information received during three years of experimental teaching, the subject groups arrived at "workable conclusions regarding the nature of the content and scope of the new teaching materials to be produced." (Tamarin, 1973, p. 7) It was recognized that the materials used in experimental teaching could serve well as a basis for further development in the improvement and restructuring of science education. Only minor modifications were found to be necessary in the subject syllabi but considerable changes were required in the approach and content of textbooks and teachers' guides.

These changes in approach and content were meant to reduce the load of information in the instructional materials provided so as to offer scope for acquisition of deeper insight into the elements of main scientific theories.

This UNESCO-UNICEF project on the improvement and restructuring on science education at the school level was again a cooperative joint venture in which the NCERT, the State Governments, the UNICEF and the UNESCO collaborated with each other. The programme of reorganisation and expansion of teaching of science throughout the school stage in India was initiated by the Union Ministry of Education, in consultation with the State Governments and other agencies in 1967. (Ministry of Education, 1967).

The different facets of this programme were the development of model curricula, syllabi and teaching materials for separate science subjects and mathematics (Classes six-eleven) production of simple sets of teaching/learning equipment for teacher's demonstrations and pupils' experiments, training of the NCERT counterpart personnel for development of new teaching materials and materials for evaluation of pupil's performance, training of teachers and key educational personnel in the various States for the process of development, evaluation and adaptionof the project materials in actual classroom practice, extending of the experimental programme progressively from the selected experimental schools to other schools of all States of India. UNESCO-UNICEF offered assistance to this programme and subsequently the project gained momentum in 1969, under the operational assistance and supervision of NCERT. Extension of the project was agreed to primarily a State responsibility and the UNICEF agreed to assist five per cent of primary and thirty per cent of middle schools in all State and Union territories.

The implementation of UNESCO-UNICEF Science Teaching Project (SEP) was stipulated in three phasese namely, (i) Pilot Phase. (ii) Wider Introduction Phase and (iii) Universalised phase. The programme was projected for the Fourth and

Fifth Plan Programmes for improvement of science teaching at school stage. During the period under review work on the pilot phase was done byNCERT in consultation with the states. The Plan of Operation detailed out the objectives of the programme —the developmet of new syllabi, the development of new instructional materials, training of Science educators and science teachers at different levels, provision of necessary science materials to selected institutions, introduction of the revised syllabi and instructional materials in the schools, upgrading of key institutions as well as provision of Science Mobile Labora-taries. It also envisaged the responsibilities of participating agencies viz., the Ministry of Education and Social Welfare, National Council of Educational Research and Training (NCERT) and the State Governments. One of the important tasks of the State Government was the setting up of State Institute of Science Education or its equivalent and to provide staff as per prescribed norms. A need was felt for developing a 'package programme' of new teaching materials including 'kits' of equipment and 'teachers' guides' and 'kit guides.' The phase of preparation of the modified versions of teaching materials for middle and secondary schools started in early 1967 with the experimental phase and continued till the end of the Project in 1972. On the basis of experimental teaching and feedback it was decided that the package programme of teaching and guidance materials for middle school would consist of Syllabi, Textbooks, Teacher-guides, Demonstration kits, Pupils' Experiment Kits, Kit guides, Audio-Visual aids, Evaluation guides, Model test papers and Question banks. Together with these, a number of teacher-training materials were produced specially for training teachers of experimental and pilot schools and also manuals for using the laboratory equipment supplied by UNESCO under thr equipment component. The materials developed were, as pointed out by Tamarin, "designed with room for adaptation for younger school age (classes 5, 6, 7 instead of 6, 7, 8) and for different local standards of general education in various States." (Tamarin, 1973, p. 9) By 1972 the materials (Appendix E) were developed which on one hand illustrate the kind of work done in the project and on the other hand indicate the nature of materials and also to serve as a guide for future projects.

As observed by Director, NCERT. the syllabi and materials were "based largely on the pattern of materials used in the schools of the U.S.S.R. where science is taught as separate disciplines from the middle stage." (Aiya, S.V.C. Director NCERT, Physics Book—Science for Middle Schools, NCERT) Since 1930, in U.S.S.R., the law on Universal Compulsory Elementary Education provided at least four years of elementary schooling throughout the country and seven years schooling in its industrial cities, factories, districts etc. compulsorily for all children from the age 7. (Deinekoh, 1957, p. 28) The total period of schooling upto the end of secondary stage from 7 to 17 was "a unified integrated school without any break at any stage." (Singh, 1961, p. 44) The school curriculum content, textbooks and equipment were same for a given class through out the country irrespective of the fact whether school was rearing children of the ages 7-10, 7-13, 7-17. (Korolev, 1958, p. 10) and even if it meant publishing the same type of book in forty-nine different languages in which teaching was done in different parts of the Soviet Union. The content of school science prescribed for I-III classes was introduction of the elements o scientific knowledge into explanatory reading, conducting off subject lessons and excursions, observations in nature and school corners of living nature and information about the human body. In IV class, natural science was prescribed which included the principles of Physics, Chemistry, Geology, Biology. Through these subjects information was provided about the complex phenomenon of nature. From V to XI (X) classes, sciences as various disciplines were taught—Botany from Class V onwards, Biology from Class VI onwards, Physics from Class VI onwards and Chemistry from Class VI onwards. (Zrerev, 1965)

A comparison of materials—Syllabi, and Textbooks developed under SSST Project prepared for the children of middle schools of our country with that of syllabi and textbooks for the children of middle schools of U.S.S.R. shows quite a resemblance between the two. Except for the fact that the Russian child was expected to learn at the age of 12^{+} what an Indian child was expected to learn at the age of 10^{+}, the equivalence of content, between the two countries, is marked. (c.f. Perishkin et.al.) The discipline approach of teaching science as Physics, Chemistry and Biology which was in vogued in the U.S.S.R. since 1931 was by and large adopted not only because of the recommendations of UNESCO Planning Mission (1964) and Education Commission (1966) but also because of the expertise provided by Russian Science Educationists and experts. Apart from fortythree UNESCO exports from U.S.S.R. who guided and participated in the development of project work, instructional materials, training of science teachers etc. fortynine Indian Science educationists from NCERT, including Regional Colleges of Education and States were also trained in various institutions in USSR in different aspects of the project work. The present investigator was himself educated and trained at Lenin Pedagogical Institute, Moscow and Leningrad, in different aspects of science curriculum development and pre-service and in-service training of science teachers.

As a consequence of this interaction the discipline approach to teaching of science influenced the development of syllabi, textbooks and instructional materials for the SSST Project.

As mentioned, the project work continued inspite of stoppage of assistance from the UNESCO-UNICEF because of the momentum it gained on account of input and efforts at the national and state level.

Assessment of UNESCO Assisted SSST Project

The UNICEF invited the Centre for Educational Development Oversees (CEDO) to undertake an assessment of the School Science Education Project. The three member CEDO team visited India during the period mid-January to early March, 1971. The CEDO Team (1971) observed that there were differences in what were described as the elementary, middle and secondary (or high school) stages of education. Most of the States assigned the word "middle" either to classes V, VI and

VII or to classes VI, VII and VIII. Consequently, as pointed out by CEDO team, "two patterns were bound to emerge." From the alternative patterns, alternative definitions followed of what were referred to as elementary school, a middle school and a secondary or high school. Usually by an elementary school was meant a school catering either for Class I to IV or for Classes I to V. Middle school meant a school catering either for Classes I to VII or for classes I to VIII and by a secondary school or a high school, a school catering either for classes V to X (or XI) or for classes VI to X (or XI). There were some secondary schools offering education only in classes VIII to X or IX to XI. (Ibid, p. 5) The CEDO team concluded that middle schools overlapped elementary schools, and that secondary schools also overlapped middle schools. These overlapping definitions for school stages, as pointed out by CEDO team had implications for the improvement of Science Educa tion. The CEDO team observed that what the "team has in mind are cases they encountered where—States have adopted, with little modification, NCERT texts designed for classes VI, VII, and VIII tried in Delhi schools and are using them for classes V, VI and VII. (Ibid., p. 57) Some of the significant observations of the CEDO team were: "... Teachers are already pointing out that language difficulties have arisen ... conceptual difficulties are also present. This is not surprising where NCERT texts validated by trial in Delhi schools, are being used in rural areas for children who may be eighteen months younger in age than those for which the texts have been prepared." (Ibid., p. 57) Obiviously this type of difficulty arose due to the non-uniformity of the school structure though there could be other factors as well. Had the school structure been uniformed, efforts made at one place could be duplicated elsewhere avoiding additional efforts. But this could not be done so. As already discussed, this type of difficulty created by non-uniformity of school structure had been deliberated upon by the DEPSE (Report, 1962), Sampurnanand Committee (1962), Indian Parliamentary and Scientific Committee (IPSC) (1964), UNESCO Planning Mission (1964) and the Education Commission (1966). But as long as a uniform national pattern of school system did not arise the policy implementers had to act within the given constraints.

The CEDO team, in its Reports 'Science Education in India', therefore, while commenting on various aspects of the SEP recommended alternative versions of NCERT materials to be made available to the States. The team recommended that States were to be encouraged to try out development work with all the variants as well as with their own materials. The CEDO team's observations regarding the UNICEF Aided Project were:

> The pilot phase of this Project has got off to a good start. In view of the sequence of problems-practical and administrative, that have had to be solved in getting it started, the temptation is strong to describe the start as a brilliant one. The problem before India, is how to sustain the lustre of the new teaching now being given in the years ahead, and how to introduce teaching of comparable quality more widely into school systems. (CEDO Team, p. 39)

Regarding the financial implications for UNICEF (1971-74), the many recommendations of the CEDO team to UNICEF in CEDO team's words, could be summed up "drive carefully or "slow down until you can be sure that you can see the colour of the traffic lights." (CEDO team, p. 64) However, the team recommended additional finance from UNICEF and suggested to the Government of India "to take every advantage of all sources of external aid on offer, international or bilateral, to further the aims of this incomparable project." (CEDO team, p. 67) This "incomparable project" continued through the "wider phase" and "universalized phase" during the subsequent period 1972-1977 which would be discussed in thenext chapter.

Study Group Project

Concurrent with SSST project, another project—Study Group Project was started during the period under review. The project was started with a view to implement the recommendations of Education Commission which not only recommended teaching of school science as separate disciplines but suggested its teaching from class V onwards. Unlike the UNESCO Mission (1964), it recommended all the three disciplines—Physics, Chemistry and Biology to commence one year earlier. In addition, it recommended a one year course in Geology in class V and one year course in Astronomy in class VII. (q.v. Education Commission and c.f. CEDO Team, p. 12)

Under this Project the textual and instructional materials in Science were prepared for classes V, VI and VII as recommended by Education Commission (1964-66). Consequent upon the recommendations of the Education Commission (1964-66), it was considered disirable to hold a Conference of leading Scientists and Mathematicians in the country to devise a plan to improve science and mathematics education at the school level by exposing the students to better text materials. A meeting was, therefore, organized early in 1966 and the consensus at the metting was for the establishment of a number of Centres to be known as Study Groups in the Universities/Research Institutions, consisting Scientists in University and teachers working in the field to construct an articulated curriculum for the entire school stage in Mathematics and for the Secondary stage (from class V/VI onwards) for Physics, Chemistry and Biology. This task was entrusted to Universities mainly with a view to provide a wide base to the deliberations on school science curriculum and also to provide an opportunity to the experties available in the Indian Universities to make impact on teaching of science at school stage.

Twenty Study Groups in Physics, Chemistry, Biology and Mathematics at various University Centres apart from one at Doon School, Dehradun (AISTA) were established. The Groups worked in collaboration with each other to construct an integrated science and mathematics curriculum, primarily based on the approach propounded by the Education Commission. With each study group, provision was made for attachment of two practising teachers who could contribute actively to the preparation of curricular materials and to keep the scientists fully posted with the point of view of the practising teacher and the school child.

While the Biology, Chemistry and Mathematics study groups decided to work as one team with a view to produce only one set of materials, in physics, the position was slightly different. The Study Groups at Calcutta and Delhi decided to work as a team, whareas the Study Groups at Jaipur and Dehra Dun decided to develop materials on their own. One of the Directors of Study Groups in a subject was named as Convener so that he could organise meetings of various Study Groups in the subject and resolve problems involving matters pertaining to Content approach etc., relating to the preparation of curriculum materials. A Coordinating Committee, under the Chairmanship of Dr. D.S. Kothari, Chairman, University Grants Commission consisting of Conveners of all the four subjects, a representative of the Ministry of Education, Head of the Department of Science Education and Reader-in-Change of Study Groups Project in the Department of Science Education, NCERT as Member-Secretary, was constituted to review the progress of these Study Groups from time to time.

Initially the Study Groups were envisaged for a period of about two years, i.e., upto December, 1968, However, as the work progressed, it was found that the amount of effort involved was far more than was originally envisaged. The long distances at which Study Groups of a subject were situated also accounted partly for the delay in the completion of their task. Initial problems accompanying the setting up of the Study Groups also took some time to resolve. The duration of the Study Groups was, therefore, extended from time to time.

On the basis of a review of the position, early in 1971, it was found that the text materials for Biology and Chemistry for Secondary School stage had been completed and as such it was decided that with effect from April, 1971, only the Convener's Group in these subjects was to be retained. The task proposed for the Convener's Group from April, 1971 onwards was to get the materials printed to try-out these materials, to revise them in the light of feed-back obtained and to train teachers for implementing this programme.

In Physics and Mathematics work was still going on at the Middle School level and as such all the Study Groups in these two subjects except for the Physics Study Group at Jaipur were allowed to continue upto March, 1972. Besides, one more Study Group in Mathematics was created in Meerut with effect from April, 1971 consequent on the appointment of prof. J.N. Kapur, Vice Chancellor of Meerut University, Convener, Mathematics Study Group. This was done with a view to continue the line of thinking and approach that had been adopted in the materials that had already been developed. Prior to this, one Study Group in Physics had also been created at Nagpur with effect from April, 1970 and this Study Group started writing materials in coollaboration with the Calcutta and New Delhi Study Groups.

The position about the progress of the work of Study Groups was again reviewed by the Coordination Committee in a meeting held in March, 1972 and it was noted with satisfaction that the Physics Study Groups had already completed Physics Book I and Book II for High School stage except for 'Mechanics' Section, and work started on Physics Book III.

The Mathematics Study Groups had similarly developed Mathematics Book for the first two years of the High School. It was, however, felt that it might took about one more year to complete these manuscripts in press-worthy form and to get them printed. Therefore, the duration of all the remaining new study groups was extended for one more year upto March, 1973 with the hope that the Project would be over by that time. The Textbooks, Teachers Guides, Lab. Manuals developed under the Study Group Project are given in Appendix F.

A limited try-out of instructional materials started at places where the Study Groups were situated, at the middle school stage, on the initiative of the local Study Group Director. The modus operandi adopted for this try-out was to invite classroom teachers to the Study Group office once a month or so and to discuss with them the major concepts involved in teaching the new programme. The study group members also visited the experimental schools at their convenience to see the reactions of the students. Feed-back was obtained from teachers about the suitability and teachability of topics included in the curriculum materials, and the comments so received were used while revising the materials. The Study Groups materials were also sent to the Summer Science Institutes for obtaining comments.

A few States did show some preference for trying out the Study Group meterials in their project schools. The State of Tamil Nadu and the Union Territory of Pondicherry incorporated materials from Biology textbooks in their adapted versions. Gujarat also decided to use the textbooks produced by Chemistry Study Groups. Some voluntary organisations in Madhya Pradesh also used the Study Group material, for instance Science Teaching Programme in Hoshangabad used the Physics book prepared according to the approach adopted by Nuffiled Project (U.K,) by All India Science Teachers Association Study Group. However, the materials produced under the Study Group Project, as pointed out by Pitre, the Director of AISTA Study Group, "hardly found implementation in any school system in the country." (Pitre, 1978, p. 76). According to Pitre, the main reason for the failure was inclusion of such individuals in Study Group teams who had little experience of classroom conditions. Over and above this, adequate and systematic trials of the curricular meterials developed were not carried out. And finally, the responsibility for implementation of the courses was the NCERT which was itself developing alternative curricular materials for schools under UNESCO.—UNICEF Project. (Pitre, 1978, p. 76).

Summer Science Institutes

The manpower involved in the Study Groups, by and large was associated with the work of Summer Science Institutes and some of them were also involved in Textbook Reform Project—Panels and Editorial Boards. The Panels and Editorial Boards were set up in pursuance of the suggestions made by

Indian Parliamentary and Scientific Committee--IPSC (1964) and subsequent recommendations of CABE (1964) to prepare the books for Indian Schools in different Subjects such as, Physics, Chemistry, Biology, General Science, on the lines of the books prepared in U.S.A. as a sequal to what was known as the structure of the Discipline Movement in America. On reviewing the work of Panels, it was found that the Panels had taken rather long time to finalise the instructional materials. In order to adopt a simpler method, Editorial Boards were instituted. These Panels and Editorial Boards considered and used the new instructional materials produced in U.S.A. under different projects. For instance, Chapter VI of the Book, Part I Mechanics—Properties of Matter prepared by Physics Panel and Editorial Board was reproduced from PSSC Physics. (NCERT, 1968, pp. 47-68) Similarly, various kind of materials such as, School Mathematics Study Group (SMSG), Biological Science Curriculum Study (BSCS) and Chemical Bond Approach (CBA) etc. were frequently used in Summer Science Institutes organised to orient secondary school science teachers of our country with the objectives:

(a) To establish channels of communication between schools and universities;

(b) To enable teachers to develop a better understanding of the basic concepts and recent developments in their subjects;

(c) To assist teachers to conduct experiments wherever possible with simple and improvised apparatus and to encourage further experimentation along the lines leading to consideration of theoretical ideas arising out of experiments;

(d) To strengthen the capacity of the teachers for motivating able students to develop an aptitude for research;

(e) To stimulate interest in teachers by bringing them into contact with eminent men in the field of their study, and

(f) To enable teachers to exchange views with their colleagues in the profession and thus promote a greater understanding and appreciation of each other's teaching problems. (NCERT, Report of Summer Science Institute Review Committee, 1972. p. 4)

Indeed, these materials which came from U.S.A., a country technologically developed and far ahead of our country were "the basic materials on which programmes were organised." (Ibid, p. 9).

In 1963, three Summer Institutes were organised in collaboration with University Grants Commission and their course content included a substantial programme of science and mathematics courses which was prepared to meet the emerging need of science education in U.S.A. where there was "again an emphasis on content disciplined knowledge and the lifting of the intellectual level by a return to compartmantalized subjects, even in the elementary schools". (Taba, op. cit. pp. 392-393) During later part of 1950s and 1960s this emphasis on content in school science curriculum led to significant changes in school science curriculum in American Schools. One of the characteristics of the reform movement popularly known as the 'Structure of the Discipline Movement', as pointed out by Goodlad (1966) was to make School Curriculum "discipline centred rather than child or society centred." (The Changing School Curriculum, p. 9) The argument put forward for "The Structure of the Discipline Movement' was that a systematically taught subject "provides disciplined knowledge and trains in special systems." (Cronebach, Cited by Taba, p. 387) It arose as part of an emphasis in competence, proficiency, power, and excellence stressed by political, military, business leaders, and by scholars particularly in the natural and technical sciences. Central to this theory was that teaching had to stress the underlying concepts processes and characteristic of each field of scholarly inquiry, such as Mathematics, Physics, Chemistry, Biology and Humanities. Hence reference was sometimes made to 'Process Objectives' or 'Processes Teaching.' (Mason, pp. 21, 23, 136)

It was also referred to as 'Concept Teaching' or 'Concept Learning' and some were fond of using the term 'Inquiry or Inquiry Teaching' to refer to it. During the late 1950s and early 1960s, a large number of academic scholars and leading educationists participated in a sustained effort to locate and define the basic structural elements of each of the major academic disciplines which were to be organised according to their inner relationships to one another in making up a given intellectual discipline.

It became so important that it strongly influenced revisions of school curricula in a number of basic academic fields, and number of projects came up, such as, School Mathematics Study Group (SMSG), Greater Cleveland Mathematics Programme, The Madison Project of Syracuse University and Webster College, University of Illinois Committee on School Mathematics, University of Illinois Arithmetic Project at Educational Services Incorporated, University of Maryland Mathematics Project, Computer-Based Mathematics Instruction (Experimental Teaching of Mathematics in the Elementary School), Biological Sciences Curriculum Study, (BSCS) Chemical Bond Approach Project, (CBA Project), Chemical Education Material Study, (CHEM Study), Physical Science Study Committee, (PSSC), Science Curriculum Improvement Study, Elementary Science Study, Science—A Process Approach and some programmes in Humanities and Art and Health Education (Goodland, et. al, 1966, The Changing School Curriculum, Passim) Mason, discussing different systems of educational theory which strongly influenced schooling of children in the United States of America observed that "the liberal arts traditions (Subject Centred) and progressive education (Broad Fields Curriculum) were important mainly before World War II. . . . were very much opposed to one another. The Structure of the Discipline Movement had been important mainly since World War II" (Mason, 1972, p. 1) It is this structure of the Discipline Movement which made some of the Science Curriculum Policy makers realize the need to orient Indian School Science teachers with modern approach to curriculum construction and new strategies of teaching. It is this which led to expansion of Summer Institutes programme.

Subsequently, these Summer Institutes were held at different places in different science subjects in cooperation with NCERT, University Grants Commission and National Council for Science Education. Expert assistance was made available by the U.S. Agency for International Development—(USAID). Two hundred Ninetytwo Summer Science Institutes Physics (105), Chemistry (109) and Biology (78), were organised during the period 1963-1971. (NCERT, Report of Summer Science Institutes Review Committee, pp. 4-5).

From time to time the working and methodology of Summer Institutes were evaluated by the organisers and groups. After a decade, however, it was decided to transfer the responsibility for running Summer Institutes at the School level, completely to the NCERT from the Summer of 1972. A review committee was appointed by NCERT under the Chairmanship of Shri M.V. Rajagopal and Shri G.S. Baderia as member Secretary. The Committee reviewed the 'task of coordination between Summer Institutes and other programmes of science improvement, non-involvement of State Education Departments, suitability of programme and staff, lack of incentive and lack of a well coordinated plan of follow-up work, and commented on all the above aspects of the programme. One of the significant points on the muddle of the policy of school science education was the coment of participants, recorded by the Committee, viz., "what is the use of attending the Institute if I cannot put the ideas into practice because of rigidity of course content and the over-powering influence of the external examination system." (Report, p. 9)

Review

Looking back, during the period 1967-72, efforts were mounted to implement the recommendations of UNESCO Planning Mission and Education Commission. National Policy on Education was declared according to which emphasis was to be laid on the development of science and technology education' which were necessary if the country was 'to attain its rightful place in the cultural heritage and its unique potentialities. The Government of India was also directed to review the progress of education every five years.

The Planning Group on Education gave high priority to the development of science education laying emphasis on the development of scientific attitudes and skills as it found the teaching of science in schools far from satisfactory, and recommended various measures which were approved in the Fourth Five Year Plan. But the outlay came to only about fifty per cent of the amount which was required. So hardly a few programmes were taken up for implementation.

For the slow progress of the implementation of progress according to National Policy on Education, the main reason cited was that 'centre has no authority over education—education being a state subject. The Centre could indireclty influence educational policies of states through substantial financial aid. Inspite of reduction in the outlay for centrally sponsored sector of education, the Government of India provided substantial aid for the implementation of the UNESCO-UNICEF aided project which in words of CEDO team was 'incomparable project'.

The UNESCO aided Science Teaching Project was stipulated in three phases (i) pilot phase (ii) wider phase and (iii) universalised phase, beginning with an experimental preparatory phase with Delhi Schools.

The syllabi, textbooks and materials prepared under the project had quite a resemblance with the syllabi, textbooks and materials meant for Russian children. The Indian child had to learn at the age of 10^+ what the Russian child was expected to learn at the age of 12^+. The approach—teaching school science as separate subjects Physics, Chemistry, Biology from the middle stage which was in vogue in USSR since 1931, was adopted by and large in India. The CEDO team made an assessment of the science project and drew attention towards the difficulties created by non-uniformity of school structure, which was mainly responsible for duplicating of efforts, waste of time and money. It found that the instructional materials prepared for Class VI, VII, and VIII, at many places, were adopted for classes V, VI and VII. However, it suggested the trial of other variants of the materials prepared under Study Group Project. Twenty one Study Groups were established to implement the recommendations of Education Commission which desired to see teaching of school science from class V onwards. Unlike the UNESCO mission it recommended all disciplines to commence a year earlier. In addition, the Commission also recommended a one year course in Geology in class V and one year course in Astronomy in class VII. Though, a lot of work was done under the Study Group project, but as pointed out by one of the Directors, it hardly found implementation in any school system in the country. The reason cited was that the teams consisted of individuals who had little experience of classroom conditions. Perhaps, much more significant was the reason that the responsibility for implementation was with NCERT which was developing another set of instructional materials according to the recommendations of UNESCO Planning Mission, for classes VI, VII and VIII. Thus, on one hand, instructional materials prepared under UNESCO-UNICEF Project in which Russian Experts and Indian Experts trained in USSR contributed, and on the other hand instructional materials prepared under Study Group Project in which Indian University Professors contributed on the lines of various projects under the Structure of Discipline Movement in America were made available concurrently.

The manpower involved in Study Oroup Project, by and large was also associated with Panels and Editorial Boards for preparing model textbooks on the existing pattern prevalent in U.S.A., where there was 'again an emphasis on content, disciplined knowledge and lifting of the intellectual level by a return to compartmentalized subjects even in the elementary schools'. Under this, a variety of materials such as, PSSC, BSCS, SMSG, CBA, etc. were produced. These materials were the basic materials on which the Summer Science Institute programme was organised to orient the Secondary School Science teachers with the new trends of teaching their subjects. However, the Review Committee noted the comment of participants that due to the rigidity of course content and external examination system, the training imparted to Secondary School Science teachers was of little use.

REFERENCES

Aiya, S.V.C. 1970, *Physics Book Part II, Middle Schools*, New Delhi: NCERT.

Brioukhanov, A. V. 1967, *India Physics Secondary Schools Science Teaching Project, New Delhi (December, 1964—November 1966)*, Paris: UNESCO.

CABE, (1968), *Proceedings of the Thirty Fourth Session of the CABE, Part I.* New Delhi: Ministry of Education and Youth Services (Government of India).

CABE, 1970, *Proceedings of the CABE's Thirty Fifth Meeting*, New Delhi: Ministry of Education and Youth Services (1971).

CABE, 1970, Proceedings of the CABE's Thirty-fifth Meeting in (*Biswas, A and Agrawal, Suren. (Ed.). 1971, p. 105*).

Centre for Educational Development Overseas. (CEDO). *Science Education in India.* (An Assessment of UNICEF aided Project on Science Teaching at the School Stage), London: The Centre for Educational Development Overseas Tavistock Square London, WEI.

Commitee of Members of Parliament on Education, 1967, *National Policy on Education.* New Delhi: Ministry of Education (Government of India).

Deinekoh, M. 1957, *Forty Years of Public Education in USSR.* Moscow: Foreign Language Publishing House.

Educator's Comment, 1971, in (Vaidya. N. 1971. *The Impact Science Teaching.* New Delhi: Oxford and IBH Pnblishing Co.)

Government of India, 1968, Policy Resolution on Education, in (Education Commission, 1964-66). *Education and National, Development.* New Delhi: Reprint by NCERT.

Goodlad, (et. al). 1966, *The Changing School Curriculum*. New York; The Fund for the Advancement of Education, 477, Madison Avenue.

Korolev, F. 1958, *Education in the U.S.S.R.* New Delhi: Soviet Land Booklets.

Kapoor, J. N. 1969, Study Group in Mathematics—Jadavpur University and NCERT Mathematics Study Groups. *School Science, Vol. VIII, No. I, 1969 p. 78*).

Mason, Robert, E. 1972, *Contemporary Educational Theory*. New York: David Mckay Company, Inc.

Ministry of Education, 1967, *Plan of Operation* (*UNICEF Aided Projects on Science Teaching at School Stage*). New Delhi: Minstry of Education.

Singh, Raja Roy, 1961, *Education in the Soviet Union*. New Delhi: Ministry of Education.

Singh, Raja Roy, 1961, *Education in the Soviet Union*. New Delhi: Ministry of Education.

Ministry of Education, 1968, *Annual Report* (*1967-68*), New Delhi: Ministry of Education, Government of India.

NCERT, 1968, *Mechanics Properties of Matter* (Physics Book prepared by Panel and Editorial Board). New Delhi, NCERT.

NCERT, 1972, *Report of the Summer Science Institute Review Committee*. New Delhi: NCERT.

Physical Science Study Committee (PSSC) 1965, *Physics*, (Second Edition). Boston: D. C. Heath and Company.

Perishkin (et. al.), 1964, *Physics for the Sixth Form, Physics for the Seventh Form and Physics for the Eighth Form*. Moscow: Publishing House, Provesh Cheniya.

Perishkin, A. B., (et. al.), 1950, *Physika, Part-II* (*Textbook of Physics for Class VII*). (in Russian Language) Moscow:

Perishkin, A. B.˙ (et. al.), 1949, *Physika Part I*, (Textbook of Physics for Class VI). Moscow: (in Russian Language. Total Pages 136).

Planning Commission, 1968, *Educational Development in the Fourth Plan* (1969-74). (Report of the Planning Group of Education). New Delhi: Planning Commission (pp. 145-156).

Planning Commission, *Fourth Five Year Plan*, (1969-74). New Delhi, Government of India.

Pitre, B. G. 1970, Progress Report on AISTA Physics Study Group, *Vigyan Shikshak, Vol. XIV, No. 4*, 1970, p. 2).

Pitre, B. G., 1978, 'Strategies for Curriculum Diffusion' in (*Proceedings of* *the Conference on Science Education.* Khiroda, January, 17-19, 1978. Homi Bhabha Centre for Science Education, TIFR, Bombay.

Subha Rao, N. V. 1969, The NCERT Project on School Chemistry (*School Science, Vol. VII, No. 2, 1969, p. 137*).

Taba, Hilda, 1962, *Curriculum Development*, New York: Harcourt, Brace and World, Inc.

Tamarin, A., 1973, *India Secondary School Science Teaching* (*December, 1964—December, 1972*), Paris UNESCO.

Zverev, I. D. 1965, 'System of Teacher Training in the USSR' in (*School Science, Vol. IV*, No. 4 pp. 313-317)

American Association for the Advancement of Science, *The New School Science* (A Report to School Administrators on Regional Orientation Conferences in Science). Washington: American Association for the Advancement of Science.

Bingham, N. E., (Dr. and Mrs.), 1962, 'The Unit Approach to Teaching Science' in (*School Science, Vol. I, No. 2*, December, 1962. pp. 62-65).

Biswas, A and Agrawal Suren, (Ed.), 1972, *Indian Educational Documents Since Independence.* New Delhi: The Academic Publishers (India).

Department of Science Education (NCERT), 1967. *Syllabus of Science and Mathematics for the Middle School Level*, New Delhi: NCERT. (an Experimental Project for the Improvement of Science Education in Schools).

Department of Science Education, 1969, 'Secondary School Science Teaching Project' in (School Science, Vol. VII No. 3, pp. 249-252.

Department of Science Education (NCERT), 1970, *Science in Primary School Revised Syllabus.* New Delhi: NCERT.

Department of Science Education, 1972, *A Brief Statement for Presentation Before the NIE Faculty, NCERT*: Department of Science Education, (unpublished).

Dowdeswell, W. H. and Kelly, P. J. 1968, 'The Nuffield Foundation Science Teaching Project' in (*School Science Vol. VI. no. 3 and 4, pp. 216-230*).

Indian National Commission for Cooperation with UNESCO, 1972, *Report of the Secretary—General for 1970-72.* New Delhi Ministry of Education and Social Welfare, Government of India.

Kothari, D. S. 1970, *Education, Science and National Development.* Bombay: Asia Publishing House.

Kothari, D. S. 1970, *Science and National Development.* New Delhi: Asia Publishing House.

Margolis, A. A. 1969, *India Teaching of Physics, Department of Science Education, National Council of Educational Research and Training,* New Delhi (January, 1967—January, 1969). Paris: UNESCO.

Ministry of Education, Education in India (*Annual Reports*) *1967-68, 1968-69, 1969-70, 1970-71, 1971-72.* New Delhi Ministry of Education (Government of India).

Ministry of Education, (1968), *UNICEF Aided Project on Science Teaching at the School Stage,* (Plan of Operations for the Reorganisation and Expansion of the Teaching of Science to Students Through out the School Stage in India): New Delhi Ministry of Education Publication No. 816.

NCERT, 1963, *Improved Science Teaching in Schools* (A Report with Special Reference to the Summer Institute Programme), New Delhi: NCERT.

NCERT (DSE), *Syllabus of Science and Mathematics for the* Middle School Level, New Delhi: NCERT (Department of Science Education).

NCERT, 1968, *General Science for Primary Schools-2* (A Teacher's Handbook of Activities), New Delhi: NCERT, (Department of Science Education).

NCERT, 1970, *Report on Science Education in the Regional Colleges of Education.* New Delhi: NCERT.

NCERT (DSE), 1970, *Syllabus for Science and Mathematics for the Middle Level.* New Delhi: NCERT (Department of Science Education).

NCERT, *Annual Report, 1967-68, 1968-69, 1969-70, 1970-71, 1971-72.* New Delhi NCERT.

Orekhov, O.L. and Attreya, B. D. 1976, *The System of Education in the USSR.* in (*School Science, June 1976 issue, pp. 37-46*).

Rammanna, R. 1970, Science Education in Schools in (*Indian Association for Extra Curricular Scientific Activities Calcutta, Brochure 1970*).

Sanyal, N. K. 1965, 'The Teaching of Science, and Mathematics in the USSR in (*School Science Vol. IV, No. 4.* pp. 318-323)

Scheme for the Improvement of Elementary Science iu the Fourth Five Year Plan, in (*Vigyan Shikshak, Vol. VIII, No. 3 and 4,* pp. 60-66)

Singh, Raja, Roy, 1962, 'Science Education in the Soviet Schools' in (*School Science Vol. I, No. 2, pp. 75-87*).

Sinha, Ashok and Ghosh Bina, 1969, Position of General Science in Indian Schools in (*School Science, Vol. VII. No. 2,* pp. 110-119).

Sharma, H. L. 1971, *Report of the Study Undertaken in USSR.* New Delhi: Department of Science Education (Unpublished).

Sharma, H. L. 1975, *Primary School Teachers' Understanding of the Science Curriculum of the UNESCO-UNICEF Assisted Scheme in Delhi.* An Investigation—(M. ED. Thesis), Delhi: Central Institute of Education.

State Institute of Science Education, 1970, *Report of the Survey of Facilities for Science Education in Secondary Schools in Mysore State.* Bangalore: Department of Public Instruction in Mysore, Bangalore, Government of Mysore.

Supplement on the Nuffield Foundation Teaching Projects (16-18) Programmes in (*School Science—Vol. VI, No. 3 and 4*, pp. 231-25).

Torrie, A.W. 1972, *India. Reorganisation and Expansion of Science Education at Primary and Middle Schools.* (*January, 1969-April, 1972*), Paris: UNESCO.

UNESCO (IBE), 1970, Educational Trends in 1970—*An International Survey*: Paris—Geneva, UNESCO.

Zaweed, Asharaf, 1978, *Soviet Education. New Delhi*: Sterling Publishers.

10

SCHOOL SCIENCE EDUCATION DURING 1972-77

> In primary classes I to V the subject may be environmental studies as a composite course including both the natural and the social environment in class I and II and later on as two subjects environmental studies I (natural science) and environmental studies II (social science) . . .
>
> In the age group 11 to 14 (classes VI to VIII) a number of states have already gone ahead with the introduction of Physics, Chemistry and Biology as disciplines. They may review this policy. But some other states who have not yet adopted that policy should develop integrated course upto class VIII on the pattern of Nuffield General Science programme. Some of the States may also try with groups namely, Physical Science including Physics and Chemistry, etc. and Biological Science comprising Botany, Zoology and Human Physiology, (NCERT, 1975, An Approach Paper, pp. 16-17)

If the period 1967-72 was the period of implementation of the suggestions of Indian Parliamentary Scientific Committee (1964), UNESCO Planning Mission (1964), and Education Commission (1966), the period 1972-77 appears to be another watershed so far the school science education policy was concerned. As discussed earlier, UNESCO-UNICEF aided

Science Teaching Programmes and Study Group Programmes were made available to the States for adoption or adaptation, while the UNESCO-UNICEF Aided Project was gaining momentum, an entirely new approach for teaching school science emerged during 1972-77,

UNESCO-UNICEF (SEP) Programme

As discussed already UNESCO-UNICEF programmes were continued in the Fourh and Fifth Plan periods. The programme was also known as Science Education Programme (SEP). However, as implemented it was restricted to Primary and Middle levels. During 1974-76 UNICEF assistance was phased out from the middle level, yet it had already gained so much momentum that it was adopted in one form or another, through out the country in all States through its three phaes (i) pilot phase (ii) wider introduction phase and (iii) universalised phase. Under the pilot phase, the programme was introduced in fifty selected primary schools and thirty selected middle schools. If the state was convinced of the programme's effectiveness it could go for the wider introduction phase. It was expected that for wider introduction phase the states would revise their instructional materials after getting feedback from pilot phase tryout. Under the Universalised Phase, all schools in the States/Union Territories were to be covered by introducing the new curricular materials in Science.

Four aspects of implementation of the programme were visualised from the centre:

(a) Development of new instructional materials to be provided to States as model for their consideration, adoption/adaptation, translation and printing etc.

(b) Upgrading of key Institutions (i.e., State Institutes of Science Education, State Institutes of Education, Teacher Training Colleges, Teacher Training Schools),

(c) Inservice Training Programmes

(d) Introduction of the new curricula in schools.

The new instructional materials were developed by the Department of Science Education, NCERT. The primary science package comprised (i) syllabus for class I to V, (ii) General Science Teachers Handbook of Activities (3 volumes), (iii) Textbooks for classes III to V, namely 'Science is Doing' (iv) Corresponding Teacher's Guides for Classes III to V, (v) Evaluation questions for books for class III-V (vi) Primary Science Kit and kit guide, (vii) A set of slides on 'Activity Learning of Science Processes' and (viii) Films on 'Science is Doing,' 'Know Your Science Kit' and 'Rocks and Soils.'

The overall approach for the development of materials and also of teaching science at the primary level was summed up in the textbook titled 'Science is Doing.' 'Science referred to the product aspect of science i.e., the facts, principles, laws etc. The word 'Doing' referred to the 'process' aspect. The title thus projected that it was only through the performance of activities that one can acquire scientific knowledge and skills.

The middle stage instructional materials were offered to States as two variants: Variant-I comprising syllabi, textbooks, teacher's guides etc., developed under UNESCO assisted 'Secondary Science Teaching Project', and Variant II comprising materials developed by NCERT Study Groups set up in different universities or other institutions of higher learning. Variant-I was for classes 6, 7 and 8 while variant-II was for classes 5, 6 and 7.

The States had the option to adopt any one of these variants or even develop their own after adaptation of these two variants.

The most important aspect of SEP was the introduction of new textual materials in schools. Since it was neither possible nor desirable to introduce the programme in all schools at one stroke, implementation through phases was planned. However, because of the great diversity in conditions of different States and Union Territories, there were, towards the end of this project, five to six categories of SEP implementations—Pilot Phase

(Meghalaya), wider introduction phase, universalisation after pilot and wider introduction phase, universalisation without Pilot and WIP (Chandigarh, U.P.)

The implementation of SEP at school level raised a number of problems some of which could be solved but other like transfer of SEP trained teachers could not be solved. States like U.P., under universalization phase, faced the problem of supplying kits in huge numbers, as well teacher training of correspondingly large number of teachers. Replacement of broken or consumed materials from the kits was a problem that many States solved by providing funds for this purpose·

SEP played a catalytic effect in enhancing the States's efforts for improving Science Education. A number of States (e.g. Punjab) supplied kits on their own to all primary schools. In fact, the number of kits supplied by the States was larger than supplied by UNICEF. A few States developed their own kits as well.

However, it appears that under the project the materials (textbooks, guides, films) were prepared presuming one to one correspondance between the teacher and the primary classes. Each book 'Science is Doing' was prepared to be taught by one teacher to one primary class. No one appears to have given a thought to the problem that how these books could be used in single, two or three teacher schools, which constituted 77.74 per cent of the schools in our country. (NCERT, 1978, Fourth Educational Survey, p. 8) Apart from other things, at least one broad inference could be made that the efforts to improve school science education policy were mounted in a minority of primary schools. (Five teacher primary schools and four teacher primary schools). A great majority of schools, if not neglected, appears to remain unattended. More so out of these five teacher schools and four teacher schools, most of the schools were in urban areas. Thus, it appears that the schools in rural areas could recieve little attention. But before the achievements of SEP could be consolidated even in the urban areas and extended meaningfully to rural areas the school science policy took a new turn. As already discussed the Government of India adopted National Policy on Education in 1968. Since then efforts were undertaken to work out implementation strategies of the policy directions. Upto 1972, much work could not be done and discussions continued regarding the implementation of recommendations of Kothari Commission on the structure of schools, neighbourhood schools etc. In August, 1972, Ministry of Education, Government of India appointed a Committee under the Chairmanship of Shri P. D. Shukla and Shri R. P. Singhal as its member Secretary "to suggest practical steps to be taken for implementation of the uniform pattern of 10+2+3 for school and college classes in all States and in Union Territories of the country. The Committee alongwith other recommendations for plus two stage recommended that the new classes IX and X were too early a stage for any specialization. It recommended to provide a well rounded course of general education for these classes. (Report of the Committee, Ministry of Education, 1973).

In 1973, the Ministry of Education and Social Welfare constituted an expert group under the Chairmanship of Prof. Rais Ahmed who later on became the Director of NCERT, to prepare Model Curricula for the 10+2 pattern of schooling. The Group was expanded in 1974 and through Sub-Committees Curriculum for the Ten Year School—An Approach Paper was prepared and circulated for comments to all States. (NCERT, March, 1975) Many teachers, educational administrators and educationists were also consulted. A National Conference on the curriculum was convened in Delhi in August, 1975 which was attended by about 200 educationists from all over the country. The Curriculum for the Ten Year School—A frame work was finalised and published in November, 1975 by NCERT. This framework suggested broad outline of a new curriculum for classes I-X. The report of Educational Developments in India during 1971-77 made following observations regarding the Model Curricula—new curriculum:

> It is based on the basic teaching of Mahatma Gandhi who emphasized the use of socially useful productive work as the

medium of education, Pandit Jawaharlal Nehru who emphasized Science and Technology and the development of scientific temper and Rabindra Nath Tagore who emphasized the freedom of child and a living content with nature. (Ministry of Education, 1977, p. 3)

In the new pattern of education, "the first Ten Years of school were treated as an integrated unit of general undifferentiated education" permitting the flexibility of subdivision in a variety of ways 4+3+3, 5+3+2, 5+2+3 according to local traditions and needs. (Ibid, p. 3) The Curriculum for the Ten Year School—A Framework, while accepting the school curriculum "a reflection of the ethos of that country," (NCERT, 1975, p, 1) suggested flexibility within a framework of acceptable principles and values, to cope with the rapidly expanding frontiers of knowledge in science and technology and the changing socio-economic conditions of our society, relating to the life needs and aspiration of its people. The school curriculum was recommended to include science and mathematics as an integral part of school education upto class X for raising productivity and development of a rational outlook.

Emphasizing the ideas and values put forward by Education Commission, the Curriculum for the Ten Year School—A Framework, desired "to change the present course of studies which tended to be uniform for everybody and by their duration of a full academic year tend to contribute towards inflexibility of the disciplines and channels of progress for individuals", and suggested semester length courses and units within semester course by dividing, "the entire course of studies for a given class over various subjects into smaller units," (Ibid, p. 6) Areas such as health, sanitation, nutrition, population studies, pollution, water resources, elements of psychology and culture, "which have to find a place in the modern curriculum and which are multi-disciplinary would be dealt with more easily through a unit approach." (Ibid, p. 7)

The idea of units were thought to be having two very useful possibilities (i) the units for a particular class or year of study could be put together in one volume to serve as textbook, thereby reducing the load and number of books for a student to a minimum and (ii) possibility to establish a set of commonly accepted units for the whole country. A core curriculum to be provided to secondary schools was conceived as a solution to various problems such as, shortage of paper, lack of funds, and the necessity of printing books in several languages within each stage, (Ibid, p. 8) The books were thus to have some common units and some units specifically meant for and produced by each one of the States. The units which "generally do not change rapidly with time such as those in Physics or in History" were thought of common to all (Ibid, p. 8) But keeping in view the fact that, "our Science textbooks have generally an urban bias", the framework suggested that, "the textbooks should be given so much importance in the learning of science, and to provide teachers with guides and allow them to develop their own instructional material." (NCERT, A Framework, p. 16)

Science Education at Primary Stage

Keeping in view the the fact that "for a number of children the primary stage is terminal stage," it was thought necessary 'to provide an education to them which prepare them for life and for self learning." (NCERT, A Framework, p. 10) Science was to "be taught as environmental studies ; in classes I and II and a composite course including both the natural and the social environment and later on as two subjects viz., environmental studies I (natural science) and environmental studies II (social studies)" (Ibid, p. 16) The purpose of science education was reiterated "not to stuff the minds of children with facts and information but to sharpen their senses to enable them to observe their environment and to enrich their experience." (Ibid, p. 16) This approach appears in contrast to the approach of Education Commisson which advocated that "the aims of teaching science in the primary school should be to develop proper understanding of the main facts, concepts, principles and process . . . Both deductive and inductive approaches should be utilized to unravel these ideas though more emphasis may be laid on the deductive approach or the use of the scientific method." (Education Commission, 1964-66, p. 344)

It appears that the Framework Policy makers were attempting to be in step with which was happening in primary school science curriculum in other countries. For instance, in U.K. in early sixties, environmental studies was emerging in the school programme. (Martin et. al., 1972, pp. I-X) The term Environmental Education appears to have received a strong emphasis after the United Nations Conference on the Human Environment held in Stockholm during June 1972. Our Prime Minister, Smt. Indira Gandhi addressed the Plennary Session of this Conference on Human Environment, the declaration of which proclaimed 'to defend and improve the environment for present and future generations.' It led to questions such as, "can environmental studies be a subject in its own right, or it must emerge from a set of integrated, inter disciplinary studies? Whether environmental studies should be a subject or an educational approach within a curriculum ? Some agreed that it could be "a Science Centred Multi-Disciplinary Subject" and some viewed it as "an awareness, with art education providing an important avenue." Some teachers in primary schools in U.K, used environmental studies as an approach. Some teachers used it as a subject in upper schools. George Martin while discussing the development of environmental studies, reiterated the view put forward by Moray House Publications:

> It can now be accepted that environmental education is a a process and not a subject. One way of introducing environmental education in schools and colleges is in the use of environmental studies as an education approach within a total curriculum. (Moray House Publications, 1968. p. ix)

During 1972-77, the idea of environmental studies appears to have been first introduced in India in a Seminar convened by the Council for Indian School Certificate Examination in 1971, which had experts from Britain, Mr. R.M. Evans and Mr. D.H.W. Thomas who came to India through CEDO. Some Public Schools participated in the Seminar. Historically, the teaching of environmental studies started in our country in (1) St. Ursula's High School, Madras, (2) Church Park Training School, Madras, (3) Holy Angels' Convent, Madras, (4) St.

Keving High School, Royapuram, Madras and (5) Pratt Memorial School, Calcutta since 1971. The participation and experimentation with the idea of Environmental Studies in Indian situations were identified as being 'quite a success' and documents relating to it were brought to the notice of Ministry of Education—around mid-1973. The Ministry of Education convened a meeting of representatives of NCERT and Kendriya Vidyalaya Sanghathan in August, 1973 to explore the usefulness of "this new approach in the Indian situation." The members of the meeting were also exposed to the instructional material presented bv the British High Commission.

After a review of this material on environmental studies and a discussionn thereon the group felt that:

(i) It would be useful to provide a set of books on environmental studies produced in U.K. to each of the Teacher Training Colleges in the country. NCERT should explore the posibility of obtaining the books . . .

(ii) NCERT should send one or two officers to Calcutta and Madras to see the experiments being conducted there and to report on the usefulness of the new approach in the Indian situation;

(iii) After studying the material available on environmental studies, the NCERT should prepare a paper on the subject and send it to the Curriculum Development Committee which is already engaged on the development of new Curricula, for the children. (Courtsey, Prof. A.N. Bose)

Accordingly the schools were visited by NCERT experts and it was decided to discuss the issue in a workshop for primary science held at NCERT to identify some concepts for Environmental Education and Nutrition Education. Such a workshop was held in February, 1974 at NIE. At this workshop a paper on Environmental Education was presented by Doraiswamy. It was suggested that "Environmental Education concept should be introduced in the curricula of various disciplines." (Doraiswamy, 1974.) The participants of the workshop for primary science identified certain concepts and suggested methods of inclusion of the same within the existing syllabus. The papers and discussion reports of this workshop together with other documents were presented to the Curriculum Development Committee set up by the Ministry of Education for developing Model Curriculum of the Ten Year School which, as discussed earlier, was extended in 1974 and developed the framework of the Ten Year School Curriculum.

On examining the question of what type of science courses were to be introduced at various levels of school system of 10+2 pattern, the framework recommended "that the child should learn the method of enquiry in science and should begin to appreciate science and technology in the life and world around him." (Framework, 1975, p. 11) Keeping in view the variations depending upon the environment of the child it was proposed to use the equipment and materials locally available to teach the science. The framework approach was further elaborated by the Department of Education in Science and Mathematics, NCERT. Nature was suggested to be used as a laboratory for teaching science under the name Environmental Studies II (General Science). Some other observations in the detailed syllabi which appear to be an echo of what National Basic Education listed were:

1. The main objective is to enable children to observe their environment and to enrich their experience, thereby developing skills in the processes of science, such as observing, communicating, measuring, making a guess (Hypothesising), experimenting to test the guess.
2. Besides developing skills in some processes of science, the children, through Environmental Studies II, will gain knowledge of scientific facts and principles, and have a better understanding of the phenomena taking place in the environment around them.
3. This understanding of the environment through application of the scientific method (the processes of science)

will help children to develop a scientific attitude in life, which may comprise such components as rational outlook, open-mindedness, a positive inclination for democratic, secular and socialist outlook to situations in life, opposition to the pre-judices based on sex, caste, religion, language or region.

4. Children will be helped to develop their creative faculties—their imagination and independent thinking for locating problems, suggesting solutions and trying out their ideas. (NCERT, 1976, Syllabi for classes III-V, pp. 45-46)

The units suggested were: The earth and the sky, weather, soil and its relation to crops, force, work and energy, materials and their properties, housing and clothing, living things, human body, nutrition and health, and under these units the content was mentioned under major ideas and minor ideas for class III, IV and V. (Ibid, p. 45) These units have a close resemblance with the units recommended by Taradevi Seminar during the period 1952-57 (Appendix A)

Be that as it may, environmental education cut across the entire gamut of school education that was planned to be provided through the relevant subject disciplines. Thus in the form of Environmental Studies a composite course for classes I and II, and from class III onward as Environmental Studies I (Social Studies) and Environmental Studies II (General Science) emerged within a decade of discipline oriented approach.

A Review Committee with Shri Ishwar Bhai J. Patel as Chairman and Prof. A. N. Bose as Member Secretary reviewed "the stagewise and subjectwise objective identified in the NCERT document—the Curriculum for the 10 years School." It again recommended Science Education for classes I-IV/V in the form of Environmental Studies including social studies, nature study and health education. It may be mentioned that Education Commission and Curriculum for Ten Year School' included only the two components—social studies and natural sciences while the Review Committee added another component—Health

Education. (Ministry of Education and Social Welfare, 1977, pp. 7-8). It is due to such opiniated recommendations in the absence of proper experimentation and research studies conducted from local level to national level, that possibilities were opened up for inclusion of language, art, drawing, and other socially useful productive activities suggested for the primary school children in Environmental Studies. Terry who perceived "all education is Environmental Education" observed:

> The pleas for development of environmental education as a new subject have mispresented the problem, which is to change the environmental education that is provided in the study of any subject and in any classroom according to our best understanding of evvironmental realities. We must realize that all educational situations contribute to environmental education. Environment is no single subject and is certainly not the property of a given teacher or classroom. (Terry, 1971)

In the same vein Srivastava et. al., observed:

> The environmental studies approach is, however, not against the teaching of a subject whether in the area of sciences or social studies as long as the environment is used as a basis for providing experience to the young learner. It is, however, suggested that this division into subjects is not made at too early a point in the child's development. An approach to the teaching of Environmental Studies is to develop in students the skills to observe, investigate and draw meaningfull generalization about the problems faced by people and society, and find ways and means of resolving them. The inculcation of positive values towards work, study and health is as integral expected outcome of this approach. (Srivastava et. al., 1980, pp. 5-6)

However, the Environmental Studies programme was tried at national level under the different component of science education programme as well as in the form of some independent projects. It was also tried out in schools of Delhi Municipal

Corporation by its team of science officers/advisers from Science Branch of Delhi Directorate of Education with Mr. R. M. Evans and Mr. A. J. Young, of U. K. as experts. As a result of work done in Environmental Studies for selected Delhi Municipal Corporation classes I-II, a guide was prepared in which it was observed that "if we study any environment we find that its specific features are due to a number of inter-related factors . . ." and accordingly it was posited that, "Any environmental study should include some of the skills and knowledge of history, geography and science." (Municipal Corporation, Delhi, page, 1) It was also advocated that:

> In practice, adopting an integrated approach to the study of any environment also produced a deeper understanding. As teachers, however, we must realize that calling a particular exercise "history, geography or biology" involves adult concepts. Young children do not think in these terms. When children examine their environment, certain patterns begin to emerge. These are associated with three things—the structure of living and non-living things in the environment, their locationin the environment and the changes that have occured and are occurring in the environment. (Municipal Corporation of Delhi, p. 1)

Be that as it may, Environmental Studies approach in the School Science Curriculum was propunded at a time when Science according to UNESCO-UNICEF Programme and Study Group Project was being implemented through different phases in all the States of the Country. The inclusion of Environmental Studies in School Curriculum was claimed to be based on the recommendations of Education Commission (1966) (A Framework, 1975,) But as pointed out earlier, the Education Commission did not advocate the concept of Environmental Studies when it dealt with Science in Primary Schools' (Report, p. 344). This words 'Environmental Studies' did find a mention in the para 8.19 on "Curriculum for Lower Primary Classes." (Report, p. 327) But by advocating that "The General Science approach to the teaching of science . . . adopted at the elementary stage . . . has not proved successful as it tends to make science appear somewhat formless and without structure and runs counter to its methodology," and again by positing that "a disciplinary approach to science learning would . . . be more effective in providing the necessary scientific base to young people." (Report, p. 345), it clearly took a disciplinary approach.

The Environmental Studies concept in contrast appears to be much more formless and diffuse than the General Science approach and it can in no way be related to the School Science Education Policy which was proprounded by Education Commission and was approved in National Policy on Education (1968).

To relate the education of a child with environment has been emphasized by various Committees and Commission as well as by eminent educationists of our country. But there has been such a divergence of opinion in approach in the content and methodology that it has tended to create a confusion amongst teachers and curriculum planners. While work on producing required instructional material, preservice and inservice training programmes for teachers according to one approach were underway, a new approach was adopted which led to half-hearted attempts at implementation of recommendations from disciplinary approach to Environmental Studies approach. This was another example of vaccilation in school science education policy which took place within a period of seven years and at a time when work on previously accepted policy was gaining momentum.

Science Education at Middle Stage

The middle stage, too was also regarded by the Framework Policy Makers as a terminal stage for many boys and girls and so science education was again perceived as a means to prepare them adequately to face life and to develop capacities and attitudes for productive work in which they were to participate. (NCERT, 1975. A Framework. p. 11) The Framework noting that a number of States had already gone ahead with the introduction of Physics, Chemistry and Biology as disciplines at the middle stage suggested that "some other states could develop integrated courses upto class VIII. Some of the States could also try with groups, e.g., physical sciences including physics and chemistry and life sciences, including Botany, Zoology and Human Physiology." (NCERT, A Framework. p. 16) These integrated courses were earlier suggested to be develop upto class VIII on the pattern of the Nuffield Programme (NCERT, An Approach paper. p.16) But what Physical Sciences and Life Sciences would be, was not elaborated on. It appears that the Framework did not give clearcut direction to the school science policy but introduced new shifts in school science policy knowing well that work was going on to implement the discipline approach based on the recommendations of the Planning Mission (1964) and Education Commission (1964-66), and almost a decade had already been devoted to the implementation of this approach and some States were in the 'Wider Introduction Phase' and some were in 'Universalisation Phase'.

NCERT appointed a number of Editorial Boards to develop syllabi and textbooks according to the approaches propounded in the Framework and to develop instructional materials. (NCERT Annual Report, (1973-74), 1975, p. 13) The Central Board of Secondary Education too decided to introduce the new pattern of education from 1975-76. While collaborating with it in the development of necessary curricula and textbooks, NCERT at the same time went ahead with its own curriculum development and textbook preparation. The Editorial Boards comprised of eminent members such as Professors, eminent educationists, experts in textbook production and evaluators. Twelve Editorial Boards in Social Sciences including psychology and eleven in Science and Mathematics—one for the primary stage, two for the Middle Stage (one each in the areas of Science and Mathematics) four for classes IX and X (one each in the areas of Physics, Chemistry Biology and Mathematics) and similarly four for classes XI And XII, were set up with the object of (i) finalizing the syllabi already drafted by the various Department of NCERT, (ii) visualizing the textbooks or units as well as the supplementary readers, if necessary, (iii) assigning the work to an author or authors after discussing the character and content of each book or unit and finally (iv) reviewing the manuscript and approving them for publication. (NCERT, Annual Report (1974-75), 1976, p, 16)

One such Editorial Board for Integrated Science Curriculum for middle stage was set up under the Chairmanship of Prof. P.M. Bhargava. The present Investigator had the privilege of being one of the member of Editorial Board. The Board prepared Science syllabi for classes VI to VIII (NCERT, 1976). Forty-two units from various science disciplines were suggested in these syllabi. The units could be easily identified as belonging to Physics, Chemistry, Zoology, Botany, Astronomy, Geology etc., such as Measurement, Motion, Force and Pressure, Our Universe, Heat and Its Effect, Optical Instruments, Oscilatory Motion and Sound, Effects of Elecricity, Magnetism, Air and Oxygen, Acids, Bases and Salts, Food and Health, The Particulate Nature of Matter, Living World, Reproduction, Organic Evolution and the like. With these units, 'Learning Science Part I' a textbook of Science for class VI was prepared by selecting a few units from the Integrated Science Syllabus (NCERT, 1976). In the forward of this book, Prof. Rais Ahmed, the then Director NCERT observed:

> Students belonging to the age group 11-13 have varied experience about their environment, and what is needed is to base the education of Science on this experience. Such an education will equip them with proper knowledge, skill and attitudes for a better understanding of their immediate environment and will help them to play their proper role in the society of the future which is likely to be more Science and Technology based. This objective may be attained only if Science is presented as an integrated whole. The integrated Science curriculum is an effort to present such a unified approach . . . The idea of integrated Science is not new . . . In our country at the national level this is the pioneering effort . . . (NCERT, 1977)

These observations of Prof. Rais Ahmed who was also the Chairman of Framework Group expressed the kind of mosaic that our school science policy was. On the one hand, going by 'environmental educationists' persuations, the age-group 11 to 13 was identified as having varied experiences about their environment and using the varied experience for Science. Considering the variety and diversity of local and regional environments with all their socio-cultural and economic imbalances, the integrated approach to science curriculum with more or less fixed units picked up from various disciplines—some times consistently within the boundary of disciplines (Measurement, Motion, Our Universe, Acids, Bases and Salts Reproduction etc.), sometimes based on correlation of ideas from different disciplines (Food and Health, Our Living World, Useful Plants and Animals etc.) and sometimes based on 'fused units' (Mans dependence on Plants and Animals and balance on Nature, Population, Pollution Conservation of Natural Resources) appears to be neither fish nor fowl nor the red herring. This appears to be so because of predisposition of some decision makers to have a 'national' policy and for some others to keep the autonomy of States and the local Governments intact. This led to compromises in polices earlier as well as during the present period so that no clearcut and consistent School Science Policy could be evolded.

Science Education at High School Stage

According to the Framework, the two classes IX and X usually of 14+ and 16+ of age, would complete the Ten Years of general education, Noting that the Education Commission (1964-66) advocated a minimum national standard of attainment at this level so that those areas of the country and those sections of the society which were backward could come up and compete fairly with the rest of the people, the framework posited that "while maintaining a continuity of the objectives of education from the previous years, it is necessary to pay attention to the academic subjects as well as to the knowledge and skill required for doing socially productive work." (A Framework, p, 12) Accordingly the objective of teaching science was perceived to be that "the student should have developed the competence to apply his knowledge to the solution of the problems around him." (A Framework, p. 3) The approach suggested for the middle stage (classes VI-VIII) was also suggested for these classes as well. Over and above this it was suggested that "In these classes laws and theories should be gradually introduced, taking care that they are not introduced as dogmas. Pupils should be made to understand that many models are available and one of them is the one they are learning. Open-mindedness and scepticism should be encouraged." (A Framework, p. 16) In pursuance of the recommendations made by the Framework books in Science, Physics, Chemistry and Biology were prepared by the members of the Department of Education in Science and Mathematics (NCERT) and the Editorial Boards mentioned earlier.

It is interesting to note that whereas for the middle stage Integrated Science Curriculum Unit approach was adopted, in case of Lower Secondary Stage discipline approach in case of Physics and Chemistry and 'Group' approach in case of Life Sciences including Botany, Zoology and Physiology was adopted. This indicates the kind of inconsistancies that existed between policy making and its implementation even when both were evolved under same institution and in most cases dealt by the same persons.

State Institutes of Science Education

It was mentioned in the previous chapter that thirteen States established Science Units/State Institute of Science Education which were yet to develop and to take up the responsibities for science education programme at State Level as NCERT took up the national level. This scheme for the qualitative improvement of school education for the creation of Institutes of Education (including Science subjects) in the Siates was sponsored by the Ministry of Education, Government of India in the year year 1963 on hundred per cent central assistance and later on provisions were made to establish separate Institute of Science Education under UNESCO-UNICEF Programmes. Inspite of the difficulties encountered equipping the Science Institutes in all respect, the Science Institutes in all the States/Union Territories appeared to be in a position to take up researches as as well as developmental programmes in the field of science education. The 'Evaluation Report of the Science Education Programmes (SEP) after studying the infrastructure for improvement of science education observed that:

> An infrastructure for implementation of educational programmes involving such tasks as development of curricula, teacher training and tryout in schools has been established in most States/Union Territories. This expertise and experience should be fully utilised for implementation of any such programme in future. (NCERT, 1978, Report, p. 76)

Visits to some of these Science Institutions made by the present Investigator and the information collected revealed that there were different patterns of Science Institutes, For example, in case of Jammu, the Director of State Institute of Science Education was the Principal of the Teachers Training College also. The same situation was found in case of State Instituie of Science Education Jabalpur, where Director looked after the Science Institute as well as the Teachers Training College. State Institutes of Science Education at Udaipur, Gurgaon and Patna. Chandigarh, Punjab did not have any Training College attached to them.

Thus State Science Institute personnel at some places were most of the time engaged in the day-to-day routine of teachers training work and could pay less attention to the problems of science education in schools and some other places were far remove from both teachers training and local/regional school science problem. Most of the time they were engaged in either replicating the work done at national level or in other abstract exercises. Discussing 'some current issues in Science Education, Wanchoo observed that "It is a fact that the skills and values, which pervade very naturally in the domain of Science, remain unidentified, undeveloped and unevaluated in a large majority of schools. Unfortunately, the apex agencies such as the NCERT at the National level and States Institutes of Science Education at State level have done no work to identify these skills and values." (Wanchoo, 1977, Reshaping Our School Science Education, p. 3)

Review

Looking back, the period 1972-77 appears to be a period of watershed again so far the School Science Education Policy was concerned. When work was going on to implement the recommendations of previous commission and committees and when UNESCO-UNICEF Programmes (SEP) were gaining mementum and which "had tremendous impact in boosting States own efforts for improvement of Science Education," (SEP Evaluation Report, p. 76) entirely new approaches to teach Science at school stage emerged. In 1973, Ministry of Education appointed an Expert Group 'to prepare Model Curricula for ten year School' which after expansion in 1974 prepared 'the curriculum for the Ten Year School—Framework' in 1975. This 'Model Curricula' recommended the school science to be taught as 'Environmental Studies' at primary stage, and 'Integrated Courses' at middle stage. This 'Model Curricula' repeated the vaccillations in School Science Policies. The policies enunciated appear to have a resemblance with the School Science Policies prevalent during the fifties and early sixtees. In the sixties new programmes were launched on the recommendations of Indian Parliamentary and Scientific Committee—IPSC (1964), UNESCO Planning Mission (1964), Education Commission (1966) and National Policy on Education (1968), which continued during the early part of seventies also. The approaches to School Science education programmes were found unsuitable by one group of educationists, committees or commissions were found to be reasonable during the period under view. The pendulum of School Science Education reform again swung to the otherside following the recommendations of the 'Framework'. (NCERT, 1975). There was, it appears, no concerted effort at formulation of clearcut and consistent school science education policy. There remained uncertainity and aimless compromise both in making a School Science Education Policy and its execution. Perhaps, this situation, led Wanchoo to observe:

> During the last decade or two all these policies are being questioned one after another. The Reports of two Education Commissions headed by Dr. Mudaliar and Dr. Kothari, policies and programmes enunciated and evolved by NCERT,

> work done by State Institute of Education and Science, impact of policies pursued in developed countries and a host of materials prepared by their specialised agencies on scientific lines based on adequate research and published in this country have compelled us to have a second look at our policies and materials. (Wanchoo, 1976. p. 1, Research in Science and Mathematics Education, RCE, Ajmer.)

REFERENCES

Ahmed, Rais., 1977, *Learning Science Part I—(Foreword)*. New Delhi: *NCERT, 1977.*

Doraiswami, S., 1974, *Environmental Education.* New Delhi: Department of Science Education, NCERT. (Cyclostyled).

Education Commission (1964-66), *Education and National Development.* New Delhi: Government of India, Reprint Edition, 1971, NCERT.

Martin, George and Turner Edward, 1972, *Environmental Studies.* Great Britain: Blond Educational, Zeicester.

Ministry of Education, November, 1973, *Report of the Committee on 10+2+3 Educational Structure* in Educational Documents in India 1813-1977 (Ed.), Bhatt, B. D. and Aggarwal, J. C. New Delhi: Arya Book Depot, pp. 330-331.

Ministry of Education and Social Welfare, 1977, *Report of The Review Committee on the Curriculum for the Ten-Year School.* New Delhi: Ministry of Education and Social Welfare (Government of India)

Moray House Publications, 1968, in (*Martin George and Turner Edward, 1972*).

Municipal Corporation of Delhi (Science Branch), 1978, *A Trial Guide in Environmental Studies for Selected M. C. D. School, Classes 1-2.* Delhi: M. C. D. (Cyclostyled).

NCERT, 1975, (March). *Curriculum for the Ten-Year School. An Approach Paper.* New Delhi: NCERT.

NCERT, 1975 (November), *The Curriculum for the Ten-Year School. A Framework*, New Delhi; NCERT.

NCERT, 1975, *Annual Report, 1973-74.* New Delhi: NCERT.

NCERT, 1976, *Syllabi for Classes III-V.* New Delhi: NCERT.

NCERT, 1976, *Syllabi for Classes VI-VIII,* New Delhi: NCERT.

NCERT, 1976, *Annual Report, 1974-75,* New Delhi: NCERT.

NCERT, 1978, *Fourth Educational Survey.* New Delhi: NCERT.

NCERT, 1978, *Evaluation of the SEP.* New Delhi: NCERT (Department of Education in Science and Mathematics).

Srivastava, H. S., (et. al.), 1980, *An Approach to Evaluation in Environmental Studies at the Primary Stage.* New Delhi: NCERT.

Terry Mark, 1971, Teaching For Survival—(*A Handbook for Environmental Education*) New York: A Friends of the Earth/Ballantine book (inner page).

Vaidya, N. and Rajput, J. S., 1977, *Reshaping our School Science Education.* New Delhi: Oxford and IBH Publishing Company.

Wanchoo, V. N., 1977, Some Current Issues in Science Education in (*Vaidya, N. and Rajput J. S. 1971*)

Ahmed, Rais, 1975, New Science and Old Cultures in (*Journal of Indian Education, Vol. I. No. 4,* pp. 39-42)

Ahmed, Rais, 1977, Science Education in the Rural Environment in (*Bulletin of the UNESCO Regional Office for Education in Asia. Number 18, June, 1977, Bangkok: UNESCO,* pp. 183-192).

Aiya, S. V. C., 1977, A School Science Project of India in (*Vaidya, N. and Rajput, J. S. 1977*).

Altman, Harold, 1972, 'Environmental Education for the Elementary Classroom' in (*Troost and Altman, 1972*) pp. 309-319.

Asian Centre of Educational Innovation for Development, 1977, *School Science Education in India.* Bangkok: UNESCO Regional Office for Education in Asia.

Attreya, B. D., 1983, 'Science Education Programme—Material and Implementation in (*Shukla, R. D.* (*Ed.*). *1981*) pp. 1-7.

Attreya, B. D., 1983, 'Using the Environment and Local Resources for Primary Education' in (*Shukla, R. D.* (*Ed.*) pp. 73-76.

Balzer, Levon, 1972, 'Environmental Education in the K-12 Span' in (*Troost and Altman, 1972*), pp. 242-249.

Bhattacharya, P. K., 1977, A Science class on wheels. The NCERT Takes Science to the Villages in *School Science,* September 1977, issue pp. 18-28.)

Bhattacharya, Shakuntala, 1983, 'Secondary Science Project—An Attempt to Introduce Activity Oriented Science Course' in (*Shukla, R. D.* (*Ed.*), *1983*) pp. 93-99.

CABE, *The Proceedings of the Meeting of CABE, 37th Session Publication No. 1023.* New Delhi: Ministry of Education and Social Welfare (Government of India)

CABE, 1976, *Proceedings of the Meeting of CABE, 38th Session, Publication No. 1059.* New Delhi: Ministry of Education and Social Welfare (Government of India).

Department of Education in Science and Mathematics (NCERT), 1980. *Environmental Education Pilot Project in India. Experimental Implementation of Environmentally Based Modules.* (Report UNESCO-NCERT Contract 506-940) New Delhl: DESM (NCERT).

DESM (NCERT), 1982, Integrated Science Curriculum (*For Middle Schools classes VI to VIII*)—*An Introduction.* New Delhi: DESM (NCERT).

Ganguly, B., 1983, 'Integrated Science Curriculum' in (*Shukla, R. D.* (*Ed.*). *1983*), pp. 19-25.

Government of India, 1981, *Report on Educational Developments in India, 1978-80.* New Delhi: Ministry of Education and Culture, Publication No. 1305. Presented at XXXVIII International Conference on Education (Geneva, November 1981).

Government of India, 1977, *Education in India* (*1974-76*). Report on Educational Developments presented at XXXVI International Conference on Public Education (Geneva, September 1977). New Delhi: Ministry of Education and Social Welfare.

Government of India, 1977, *Educational Developments in India, 1971-77.* New Delhi: Ministry of Education and Social Welfare (Publication No. 1098).

Guru, G., 1983. 'Nutrition/Health Education and Environmental Sanitation at Primary Level' in (*Shukla, R. D.* (Ed.). 1983). pp. 114-125.

Jacobson, W. J., 1977, Integrated Science; Methodological dimensions in (*Vaidya, N. and Rajput, J. S. 1977*).

Jain, S. C., 1976, 'Secondary Education in Switzerland' in (*School Science Vol. XIV, No. 4* pp. 43-46).

Joshi, B. P., 1977, State Institute of Science Education An Illustration in (*Vaidya, N. and Rajput, J. S. 1977*).

Kashutin, P. A., 1975, Problems connected with the reproduction of

Pedagogical Personnel in the USSR. Moscow: Lenin State Pedegogical Institute, Moscow.

Khurana, K. J., 1983, 'Supplementary Readers in Science for Schools' in (*Shukla, R. D. (Ed.). 1983*) pp. 126-131.

Lahiry, D., 1983, 'Role of Journals in Science Education with special reference to School Science' in (*Shukla, R. D. (Ed.). 1983*), pp. 132-142.

Martin, G., and Turner, E., 1972, *Environmental Studies*. (Blond's Teachers' Handbooks). Great Britain: Blond Educational, Oadby Leicester.

Masih, Savitri, 1977, 'Environmental Education' in (*Vigyan Shikshak, Vol. 22, No. 3, July-September, 1977* pp. 13-18).

Meyer, G. R., 1968, 'Environmental Science—An Experiment in Science Curriculum in New South Wales' in (*School Science, Vol. VI. No. 3 and 4*, pp. 210-215).

Mitra, J., Dutta, S. N. and Pant, K. M., 1983, 'Science Curriculum for Secondary Stage Classes (IX-X)—Courses, Syllabi, Textbooks. and Supporting Materials' in (*Shukla, R. D. (Ed.). 1983*) pp. 37-43.

Ministry of Education and Social Welfare (Government of India), 1972, *Education in the Fifth Five Year Plan 1974-1979*. (A Paper Prepared for the Consideration of the Central Advisory Board on Education). New Delhi: Ministry of Education and Social Welfare.

Ministry of Education and Social Welfare, *Annual Reports 1972-73, 1973-74, 1975-76, 1977-78, 1978-79, 1979-80*.

Moray House Publication: An Experiment in Environmental Studies, (Oliver and Boyd 1968), in (*Martin, G. and Turner, E. 1972*. p. ix).

NCERT, 1967, *General Science Syllabus, classes I to V*. New Delhi: NCERT.

NCERT, 1975, *Curriculum for the Ten Year School: An Approach Paper*, New Delhi: NCERT (March, 1975).

NCERT, 1975, *The Curriculum for the Ten Year School*. A Framework. New Delhi: NCERT (November 1975).

NCERT, 1973, The Fourth Indian Year Book of Education (Secondary Education). New Delhi: NCERT.

NCERT, 1976, *Syllabi for Classes III-V* (In accordance with the nationally developed curriculum for the ten-year school). New Delhi: NCERT.

NCERT, 1976, *Syllabi for Classes VI-VIII*. (Structure of the Integrated Science Syllabus. pp. 187-199). New Delhi: NCERT.

NCERT, 1977, *Environmental Studies, A Teacher's Guide*, Classes I-II. New Delhi: NCERT.

NCERT, (DESM), 1978. *Evaluation of the UNICEF—assisted Science Education Programme.* New Delhi: DESM (NCERT).

NCERT, 1978, *Guidelines for State Institutes for Developing—A Handbook for Teachers of the State.* (Using the Environment and Local Resources for Science Education at the Primary Stage), New Delhi: NCERT.

NCERT, Annual Report *1973-74, 1974-75, 1975-76, 1976-77, 1977-78,* New Delhi: NCERT.

NCERT, 1981, *Environmental Education at the School Level*—A Lead Paper. New Delhi: NCERT.

NCERT, 1981, *Environmental Education and NCERT.* New Delhi: NCERT.

Nuffield Foundation Science Teaching Project in (*School Science, Vol. III, No. 1*, pp. 162-176).

Recent Development in the Teaching of Science in New Zealand Schools. *School Science Vol. III, No. 2*, pp. 177-182.

Orekhov, O.L., 1977, *India General Education Science Education*). (*August 1974—August 1977*). *Terminal* Report. (FR)/UNDP/IND//68/013.

Pandey, K.D., 1981, *State Institute of Science Education in Sixth Five-Year Plan.* AISTA Annual Conference at Jabalpur in (Vigyan Shikshak, Conference Number).

Plannig Commission (Government of India), *Fifth Five Year Plan 1974-79.* New Delhi: Planning Commission.

Ranaweera, A.M., 1976, *Experiments and Innovations in Education.* Integrated Science in the Junior Secondary Schools in Sri Lanka. Paris: UNESCO.

Sinha, B.K., 1983, 'Problems and Proposals of States and Union Territories. (Printed on Behalf of the Representatives of States/UTS). (*Shukla, R.D.* (*Ed.*). *1983*). Appendix I.

Singh, Chhotan, 1975, 'Education in Science in the New Pattern of Schooling in (*Journal of Indian Eduction Vol. I. No. 1* (*1975*) NCERT. pp. 65-68).

Shukla, R.D. (Ed.), 1983, *Science and Mathematics Education* (*A New Perspective*). Report of the Conference on New Trends in Science and Mathematics Education (18th to 22nd March, 1980), New Delhi: Department of Education in Science and Mathematics, (NCERT).

State Institute of Science, Trivandrum and NCERT, 1977, *Report of the Regional Workshop* (on Use of Environment and Improvisation from Local Resources for Science Education at Primary School Stage.

State Institute of Education (Jammu), *Annual Report 1977-78*. Jammu Tawi: State Institute of Education ((Publication No. 7).

State Institute of Science Education, Bihar, 1980, *Reports alongwith Questionnaire*. Patna: State Institute of Science Education—(Registered Letter) dated 25.2.80.)

State Institute of Education, 1980, *Reorganisation of State Institute of Education and Establishment of District Institutes of Education. A New Venture* Jammu: Publication Wing of State Institute of Education (publication No. 12).

Stapp, William B., 1972, 'Environmental Encounters' in (*Troost, Cornelius and Altman Harold. 1972.*), pp. 232-241).

Stolberg, Robert, 1977, Process and Product in Science Teaching. in (*Vaidya, N. and Rajput J.S. 1977*).

Troost, Cornelius and Altman Harold, 1972, 'The Organism and its *Environment*—Nature of Environment'—in *Environmental Education: A Sourcebook*, London: Johnwiley and Sons, Inc.

Troost, J. Corneliues and Altman Harold, (Ed.), 1972, *Environmental Education—A Sourcebook*, London: John Willey and Sons, Inc.

UNESCO, 1975, *Science in basic functional education: Links with real life situations*. Bangkok: UNESCO.

UNESCO, 1975, *Science in Basic Functional: Education: Approaches, Methods, and Materials*. Bangkok: UNESCO.

UNESCO (Unit for Cooperation with UNICEF), 1976, *Basic Education in the Seventies and Science Education in the Sixties—Contrasting Characteristics Compared*. No. II Paris: UNESCO.

UNESCO, 1976, *Curriculum for Development: Analysis and Review of Processes, Products and Outcomes*. Bangkok: UNESCO.

UNESCO, 1976, *Integrated Science in the Junior Secondary School in Sri Lanka*. Bangkok: UNESCO.

UNESCO, 1977, Science Education in Asian Countries—India. in (*Bulletin of the UNESCO Regional Office for Education in Asia. Number—18. June, 1977. Bangkok: UNESCO*. pp. 36-47.)

Verma, A.P., 1983, 'Role of UNICEF/UNESCO Assistance in Science Education Programme'. in (*Shukla, R.D.* (*Ed.*). *1983*) pp. 150-165.

Wanchoo, V. N., 1973, *Science Education in the Fifth Five Year Plan*. New Delhi: All India Science Teachers, Association (New Delhi—16). 17th All India Science Teachers Conference—Presidential Address.

Wanchoo, V. N., 1977, (*Science Education at Cross Roads*. Presidential Address—21st All India Science Teachers. Conference, October 20-22, 1977. Tagore Hall, Sri Nagar, *Kashmir*.

11

SUMMARY AND CONCLUSIONS

> "A number of statements which are concurrently made regarding what needs to be done to improve education have been repeated before in countless reports. Sometimes, these are expressed in words as if they were written today. Good intensions have a long ancestry. Their transformation into action is a slow and often a very frustrating process. (Kothari, D. S. 1970, Education, Science and National Development. Bombay: Asia Publishing House, pp. 22-23).

In the present study an attempt has been made to study the evolution of school science education policy during the British period and during the period 1947-77 and some of the significant factors affecting its making as well as its implementation.

The prosperity of our country depends on the effective use of manpower which can be cultivated only by the study of science and its applications. This is so because the study of science and technology can alone provide proper manpower for the use of our material resources in a meaningful way. A proper and well-thought science education programme would help to inculcate these scientific and technical skills which are required for the development of our agriculture and industries. Even the scientific manpower needed for relevant research and its systematic application to agriculture, industry and other sectors of life can only come from a well planned system of science education right from the point a child enters the school.

Survey of researches done in school science revealed that there is a paucity of studies which deal with the evolution of science education policy indicating its implications for curriculum development.

School science education in our country presents a diversity of problems and issues which demand specific diagnosis and solutions by the country's education policy makers and professionals in science education. Inspite of the fact that we have been grappling with problem of evolving a relevant school science education policy and its effective implementation, we have not succeeded in solving it for great majority of schools. Our school science education system was affected by a complexity of factors, each of which in its own way contributed to the present state of school science education in the country for the great majority of the people. To identify some of these the present critical study of development of science curriculm at the school level was undertaken.

Modern science was introduced in India, by the European naturalists, medicalmen, engineers and other technical men. It became a part of curriculum at higher stage due to the efforts of a few individuals who expoused the cause of imparting 'useful knowledge' of sciences. The vernacular schools which were sometimes perceived 'as the only way to educate India' remained by and large neglected.

During the earlier period, there emerged two types of education—one imparted in the indigenous schools such as; tools, pathsalas, maktabs, and madarashas and other in schools managed by missions and societies. The British Government proclaimed the improvement of native population as its object and directed to appoint English teacher to teach science. The learned native was visualised as 'one who knew the physics of Newton.' It accepted the responsibility to educate a few who it hoped would form a class of interpreters between the rulers and the millions to be governed. Even though, later, the educational despatch of 1854, imposed the responsibility for education of the masses on the Department of the Administration for the Work of Education yet there was little development in school science education and these directions remained just on paper.

After the imposition of Imperial Authority on India, English language was adopted as the medium of imparting instructions in science. So only those persons had access to learn modern science who studied in English medium schools. The position of science teaching in schools was not found to be satisfactory. The Indian Education Commission (1882), recommended the inclusion of science and its applications in the curriculum right from primary classes. Its recommendations were so flexible as to be interpreted either way, inclusion of science—elements of Natural and Physical sciences and their applications on one hand and simplification, i.e., reduction of content on the other.

Again, the decisions made in 1904 for having separate science curicula for urban and rural schools was countermanded in 1913. Efforts were made to introduce agricultural courses right from the middle classes which were not welcomed by the people.

The National Council of Education (Bengal) took upon itself imparting the knowledge by science and technology through subject approach and object lessons in those branches of science and industries which were best calculated to develop the material resources of our country and attempted inclusion of scientific truths embodied in oriental learning found specially in Ayurvedic and Hakimi system. It tried to pick up the best from our scientific cultural heritage and tried to integrate it with the modern school science curriculum but it did not succeed for the one reason or the other. Though science was made compulsory in upper classes but it was not made an examination subject.

Not finding the education of the masses in a satisfactory state, Hartog gave the motto of school as being "Three R's and no nonsense" which implied no science teaching in rural schools. Again, in 1937, the education of children in primary schools as suggested by Abbot and Wood was to be based more upon the natural interests and activities of young children and less upon bookish learning, which implied separate curricula of rural and urban schools and which was in contrast with the recommendation of 1913. Thus there were vacillations in school science policy and the debate of having the same or different curricula for rural and urban schools continued. Though Basic Education emerged as 'one answer to India's needs in elementary education' and 'one of the most important events in the history of Indian education' it did not achieve much success. The general science syllabus framed acccording to National Basic Education Scheme was by and large influenced by the thinking, content and methodology popular with American Schools. For instance, curricular design of General Science had a marked resemblance to Broad Fields Curriculum Design. According to National Planning Committee (1938) the syllabus was 'ambitious' and was beyond the capacity of children and teachers. The Committee visualised school curriculum as the modus operandi for adapting school children to their natural environment, social environment and the technology. It also examined the science teaching in USSR where it was imparted through discipline approach since 1931 but did not favour it. The Committee recommended the teaching of science through an alternative approach which it called 'descriptive approach', in contrast to 'activity curriculum'. Subsequently, the Sargent Plan recognising the importance of science recommended teaching of elementary science to all pupils. Inspite of all this not much could be achieved in the area of school science education. But, in contrast with mass education, science education at the secondary and higher school stage appeared to be 'well advanced'. The tendency was to keep science curriculum at par with the existing curriculum being followed in Britain.

Not only school science policies changed frequently but also the school structure changed. Duration of schooling changed from ten years (1854) to twelve years (1917) and from twelve years to eleven years (1934) and again to ten years (1944). The necessity of having a national education policy was felt at all levels and the 'divorce' of Government of India from education was perceived as 'unfortunate'.

Thus, during the British period, one can find vacillations, uncertainty and aimless compromise both in making a school science policy and in its execution. Decisions/recommendations once made were countermanded a few years later. Policy lines were so ambiguous as to leave a latitude for local interpretations obstructing introduction of science education for the masses, on one pretext or the other. The main problem for the introduction of science in school education system had been a lack of clearcut, consistent and effective science education policy both in its making as well as in its implementation, for the great majority of our people.

During the period 1947-52, the system of Basic Education was accepted as the national system of education. Accordingly, the syllabus for basic schools was prepared which was by and large meant for mass education. The syllabus for basic schools (1950) visualised the general science approach to teach science at elementary stage in an integrated way with the activities and interests of daily life and not as a separate school subject. Besides this view, another view advocated was to teach science as systematized knowledge according to concept approach. (University Education Commission, 1948) Thus, there were two views regarding teaching of science, one general science approach and another concept approach. Moreover, the debate for having same science curriculum for rural and urban schools also continued. Thus there was no clearcut policy for science teaching at school stage. It appears that our leadership was aware of the imitation of these foreign ideas being adopted without proper educational experimentation. They wanted to build up the national system of education according to their own ideas with faith and understanding to bring about what Pandit Nehru called a revolution in the system of education.

The teaching of science was found to be not satisfactory. Whatever was proposed to be achieved could not be put to practice and the traditional method of teaching science continued. Amongst many obvious reasons, one was the inertia of the educational system.

In the First Five Year Plan, selective approach and that too stage by stage, was the policy adopted by the Government of India for improvement in the area of school science. The consensus appeared to be greared towards the general science approach of teaching science. Education itself was kept under the heading 'Social Services' and was clubbed with health, training etc. Though the role of education vis-a-vis national prosperity was recognised yet, in the planning process, education got relatively less emphasis. The Central Government accepted only a limited obligation in the field of education as the emphasis was on agriculture, irrigation and allied facilities. With education getting low priority, school science education automatically became an area which got little attention.

The period 1952-57 was the period when national efforts to improve the secondary education were mounted. The Secondary Education Commission (1953), advocating that the link stage between school and the university was not the stage for specialization, recommended 'general science course,' that is, a general introduction to all the broad and significant fields of scientific knowledge, while at the same time, it desired 'an understanding and appreciation of the fundamental principles of science.' It was not clear whether the Commission wanted general introduction to all broad fields of scientific knowledge or to provide basic understanding of fundamental principles of science. This ambiguity in policy decision was subjected to different interpretations at the implementation stage by decision makers at the national and the state level.

The Commission's decision appeared to be influenced both by the fading ideas of Progressive Education Movement, Broad Fields Curriculum and the emerging ideas of Contemporary Structure of a Discipline Movement in American Education.

These American educational ideas found an echo in the work of All India Council for Secondary Education (1955-1959) and also at First National Seminar for Secondary Science Teaching popularly known as 'Taradevi Seminar (1956). The verbai concepts such as 'Integrated Courses, Nature Study, Elementary Science, Project Units, Problem Units based on Environment Centred Topics, Life Centered Topics were borrowed from the prevalent American school science literature. In the absence of clearcut directions the courses pushed by Taradevi Seminar were in many ways a half way point between the American outgoing and contemporary school science courses as well as the traditional subject courses. Thus, school science education policy appeared to be bandied around from one idea to another idea, from one recommendation to another recommendation leading to vacillations in policy implementation.

The Central Government accepted only limited obligations in the area of school science. Even though the Government considered essential to speed up industrialisation—development of heavy industries, machine making industries and so on for national development and prosperity, its limited obligations in education were still directed towards the implementation of Basic Education. (Second Five Year Plan). Thus, there appeared a divergence between the priorities that the planners identified for the economic development and the priorities that educational planning decision makers set for themselves.

During the period 1957-62, the major school science curricular trend was still the general science programme. Government machinery made efforts to implement the policy decisions of Secondary Education Commission (1954) into practice. However, the discipline approach of teaching science—concept approach slowly but surely managed to emerge. Its echo could be heard in various seminars where in its voteries appeard to be elitist science educators. The Government Policy Resolution (1958) too tended to tilt the debate towards this approach. The Second Five Year Plan priorities and subsequently the proposals made in the Third Five Year Plan which stressed heavy and machine making industries also favoured a school education with an orientation of science teaching towards 'subjects' teaching or 'discipline' approach.

It appears that the science teachers, educators and planners did not perceive the implications of the priorities of Second Five Year Plan, proposed priorities in Third Five Year Plan and the Scientific Policy Resolution of 1958. For instance, at the primary school level, the National Institute of Basic Education (1956-1966), tried to popularise the general science approach and suggested programmes of science teaching in correlation with other subjects. Inspite of the dismal situation, Basic Education pattern continued to be supported even though no serious and well planned efforts were made to bring about necessary changes. Government machinery continued to work the way Basic Education Assessment Committee described the working in its rather critical comments. Science teaching in schools was bookish though efforts were made to popularise its practical oriented aspects and to correlate or to integrate it with other subjects and environment.

The efforts made by various agencies such as National Basic Institute, Central Bureau of Textbook Research and by some Individuals had little to show that attempts were made either to correlate or integrate or fuse various science concepts with natural environment or social environment or amongst themselves. The jigsaw puzzle of correlating science subjects among themselves in which all pieces would fit, could not be solved.

DEPSE (1959-1966) undertook various programmes to improve secondary school science education according to the recommendations of Secondary Education Commission (1953). In this, the USAID and American experts too contributed. Its programmes on science teaching were based on general science approach. The hindrances such as, questionable academic competence of teachers, non-availability of an adequate number of professionally competent general science teachers, non-availability of proper textbooks in general science and other instructional materials, resistance from state administration, the varied school systems in the states etc. in carrying out the recommendations of Secondary Education Commission were pinpointed and were discussed in various seminars and conferences by groups and individuals. These hindrances were also favoured as one of the reasons to carry the debate towards an orientation to science teaching in schools towards a discipline approach (concept approach). All this happened because of absence of the proper experimentation in the field of school science education for effective planning and implementation. The absence of proper experimentation led to divergence between the priorities that the planners identified for the economic development and the priorities that educational planning decision makers set for themselves. There appeared a hiatus between the identified objectives of planned development and the decided educational programme priorities. Perhaps, because of this hiatus between the planning priorities and implementation priorities of educational programmes to improve school science education, it appears that half-hearted efforts were put in and a clearcut school science education policy could not emerge as the parallel and continuing view points on school science teaching continued to engage educational decision makers attention.

The period 1962-67 was a watershed for the school science education policy. The concept approach advocated by elitists gained firm roots even though the so called progressive educationists idea of teaching school science according to general science approach held sway. The factual survey 'Position of Science Teaching in Schools' (1962) conducted by DEPSE found science was being taught in a variety of forms as general science at primary level but it was alternated with Music, Home Science and Drawing at middle level and was provided both under the core curriculum as well as under the elective programme at the secondary level. The Indian Parliamentary and Scientific Committee—IPSC, (1964) agreed with the DEPSE's Factual Survey that science teaching at school stage was not satisfactory. It thought that this was due to a lack of common pattern of education, differences in educational standards, and lack of coordination between Centre and States. Noting that "during the last twenty-five years objectives of school science teaching changed little, while changes in the nature of science that ought to be taught have greatly changed," the IPSC, not only recommended the 'uniformity of courses and class structure in all the States, but also recommended the upgrading of the content of science so as to bring it at par with the courses in developed countries such as, UK, USA, USSR, France, Germany and Japan. Not only this, the IPSC also stressed the need for preparing instructional materials in science on the lines of material prepared by Physical Science Study Committee (PSSC) of USA and to have similar books for all the stages. Though this was a first high power committee, which analysed school science education since independence in our country yet, it did not give clearcut directions to implementors. For, on one hand it suggested postponing the specialisation as far as possible and on the other hand commended the pattern "prevalent in USSR." It gave latitude and flexibility for the decision makers who could interpret its recommendations in any way they found convenient.

The UNESCO Planning Mission (1964), which included seven Russian and two American experts, after a study of the syllabi, equipment, teacher's competence as well as the emerging needs of the country to provide skilled and semi-skilled workers for agriculture, heavy and machine making industries, found general science—the complex topical approach 'not useful for training pupil to meet the country needs as well as for further education in secondary and higher educational establishment.' The factors, attributed to the unsatisfactory state of science teaching in schools were the legacy of a system "instituted by the ruling British power," "poverty" and "inertia of the custom." On the basis of the USSR experience, the Mission recommended a programme of science education for all the students from class I to X. Even though the National Planning Committee (1938) earlier had considered it unsuitable. The Mission recommended teaching of General Science upto class V and the teaching of separate disciplines of Biology, Physics and Chemistry from class VI onwards. CABE (1964) found the recommendations of Mission, useful for future science education in India and based on these recommendations a pilot project, Secondary School Science

Teaching (SSST) was taken up at national level (NCERT) during the year 1964-65.

The Education Commission (1964-66) identifying the need of a revolution in the educational system through internal transformation by relating it, to the life needs and aspiration of the nation, by achieving qualitative improvements by expanding educational facilities and by relating education to productivity recommended science as an integral part of education. Science teaching was 'to promote an ever deeping understanding of basic principles to develop problem-solving and analytical skills and to inculcate ability to apply them to the problems of the natural environment and social living, and to promote the spirit of enquiry and experimentation'. It found general science approach of teaching science not suited to the country's emerging need. It argued that general science did not prove successful as it was somewhat formless and without a structure. For science learning to be 'more effective in providing the necessary scientific base to young people,' it suggested the disciplinary approach. It not only reaffirmed the recommendations of the UNESCO Planning Mission but went further while recommending teaching of science as individual subjects of study as early as from class V onward. It recommended the teaching of Physics, Geology, Biology in class V, the teaching of Physics, Chemistry, Biology, in class VI and the teaching of Physics, Biology, Chemistry, Astronomy in class VI, contrary to the recommendations of Secondary Education Commission and IPSC which thought the middle stage was not a stage for specialization. However, the Commission also suggested other combinations to be tried depending upon the level of the students and local conditions thus providing an escape to decision makers and placating the different lobbies. It also provided an opportunity to decision makers to maintain the status quo or to act in any way they found it convenient.

The recommendations of Education Commission (1964-66) heralded a major shift in the School Science Policy that from a general science approach to structure of discipline approach. How far this was due to elitist's pressure and how far it went against the national aspirations of popularizing science amongst masses, can only be assessed in future, as pointed out by Sir John Adams in 'Evolution of Educational Theory' that "the present is the darkest moment in the History. It is only when it is dead and gone that something can be made out of it." The Education Commission gave a new direction for school science education policy 'deductive approach' even at primary stage and discipline approach from class V onwards, yet by allowing various combinations to be tried out and also suggesting different curricula for rural and urban school it did leave its directions sufficiently vague so as to be interpreted by the decision makers in a manner convenient to them.

During the period 1967-72, efforts were mounted to implement the recommendations of UNESCO Planning Mission (1964) and Education Commission (1964-66). National Policy on Education was declared in 1968 according to which emphasis was to be laid on the 'development of science and technology education' which was necessary if the country was 'to attain its rightful place in the cultural heritage and its unique potentialities. The Government of India was also directed to review the progress of education every five years.

The Planning Group on Education (1968) gave high priority to the development of science education laying emphasis on the development of scientific attitudes and skills as it found the teaching of science in schools far from satisfactory, and recommended various measures which were approved in the Fourth Five Year Plan (1969-74). But the outlay came to only about fifty per cent of the amount which was required. So hardly a few programmes were taken up for implementation.

For the slow progress of the implementation of progress according to National Policy on Education, the main reason cited was that "centre has no authority over education-education being a state subject. The Centre could indirectly influence educational policies of states through substantial financial aid". (CABE, 1970). Inspite of reduction in the outlay for centrally sponsored sector of education, the Government of India provided substantial aid for the implementation of the UNESCO-UNICEF aided project which in words of CEDO team (1971) was 'incomparable project'.

The UNESCO aided Science Teaching Project was stipulated in three phases (i) pilot phases (ii) wider introduction phase and (iii) universalisation phase, beginning with an experimental preparatory phase (1964-65) with Delhi Schools.

The syllabi, textbooks and materials prepared under the project had quite a resemblance with the syllabi, text-books and materials meant for Russian children. The Indian child had to learn at the age of 10+ what the Russian child was expected to learn at the age of 12+. The approach to teaching of school science as separate subjects-Physics, Chemistry, Biology from the middle stage which was in vogue in USSR since 1931, was adopted by and large in India. The CEDO team (1971) made an assessment of the science project and drew attention towards the difficulties created by non-uniformity of school structure, which was mainly responsible for duplicating of efforts, waste of time and money. It found that the instructional materials prepared for class VI, VII, and VIII, at many places, were adopted for classes V, VI and VII. However, it suggested the trial of other variants of the materials prepared under Study Group Project. Twentyone Study Groups at various University centres (one at Doon School, Dehradun) were established to implement the recommendations of Education Commission which recommended discipline approach of teaching school science right from class V onwards. For classes I-IV, it recommended deductive approach to teach science. It may be noted that, unlike the UNESCO Mission, it recommended all disciplines to commence a year earlier. In addition, the Commission (1964-66) also recommended a one year course in Geology in class V and one year course in Geology in class V and one year course in Astronomy in class VII. Though, a lot of work was done under the Study Group project, but as pointed out by one of the Directors, it "hardly found implementation in any school system in the country." The reason cited was that the teams consisted of individuals who had little experience of classroom conditions. Perhaps, much more signficant was the reason that the responsibility for implementation was with NCERT which was developing another set of instructional materials according to the recommendations of UNESCO Planning Mission, for classes VI, VII and VIII. Thus, on one hand, instructional materials prepared under UNESCO-UNICEF Project in which Russian Experts and Indian Experts trained in USSR contributed, and on the other hand instructional materials prepared under Study Group Project in which Indian University Professors contributed, were made available concurrently.

The manpower involved in Study Groups Project, by and large, was also associated with panels and Editorial Boards for preparing model textbooks onthe existing pattern prevalent in USA, where there was 'again an emphasis on content, disciplined knowledge and lifting of the intellectual level by a return to compartmentalized subjects even in the elementary schools'. Under this, a variety of materials such as, Physical Science Study Committee (PSSC), Biological Sciences Curriculum Study (BSCS), School Mathematics Study Group (SMSG), Chemical Bond Approach (CBA), etc. were produced. These materials were the 'basic materials' on which the Summer Science Institute programme was organised to orient the Secondary School science teachers with the new trends of teaching their subjects. However, the Summer Science Institute Review Committee (1972) noted the comment of participants, that due to the rigidity of course content and external examination system, the training imparted to Secondary School Science teachers was of little use.

Again, the period 1972-77 was a watershed for the school science education policy in our country. When work was going on to implement the recommendations of Indian Parliamentary and Scientific Committee (IPSC), UNESCO Planning Mission (1964) and Education Commission (1966) and at a time when UNESCO-UNICEF assisted science education programme (SEP) was gaining momentum and boosting states'own effort for improvement of science education, entirely new approaches of teaching science at school stage emerged.

In 1973, Ministry of Education appointed an 'Expert Group' to prepare 'Model Curricula' for ten year school which after expansion in 1974 prepared "the Curriculum for the Ten Year School-A Framework", in 1975. This 'Model Curricula' recommended the school science to be taught as 'Environmental Studies' at primary stage, 'Integrated Courses' at middle stage and 'Integrated courses/Groups of subjects' at high school stage. The inclusion of 'Environmental Studies' in school curriculum was claimed to be based upon the recommendations of Education Commission but it did not advocate the concept of 'environmental studies'. It appears that the 'Framework' Policy makers were attempting to be in step with what was happening in primary school science curriculum in developed countries.

Environmental studies programme in our country was included in school teaching in some of public schools in our country in 1971 after a seminar organised by the Council for Indian School Certificate Examination. As pointed out earlier, it was recommended to be the part of primary school curriculum, in 1975. The inclusion of environmental studies was approved by the Review Committee popularly known as Ishwar Bhai Patel Committee. It was interesting to note that while 'Model Curricula' envisaged only two subjects-social studies and natural sciences, the Review Committee (1977) envisaged three subjects-social studies, natural studies and health education. All these opiniated recommendations, perhaps, happened in the absence of proper experimentation and research studies conducted from local level to national level. The Environmental Study programme was tried at national level and at regional level. The guide prepared for teachers of Municipal Corporation of Delhi observed that 'any environmental study school include some of the skills and knowledge of history, geography and science". Thus one can reasonably conclude that the environmental studies concept appears to be much more formless and diffuse than the general science concept.

At the middle stage the Framework policy makers desired some states to review school science teaching and recommended the development of integrated courses, the pattern of which was suggested according to the Nuffield General Science Programme. (An Approach Paper, 1975, NCERT). The preparation of textbooks according to integrated approach was assigned to the Editorial Boards. The Editorial Board (Integrated Sciences) prepared a syllabus based on unit approach. The units suggested could easily be classified into the domain of Physics, Chemistry, Biology, Astronomy, Geology. However, some units were also there based on correlation of ideas from different disciplines and some units based on 'fused curriculum' perhaps to have a compromise between the decision makers who desired a national policy as well as keeping the autonomy of states and the local bodies and perhaps due to this compromise no clear-cut and consistent policy could be evolved and the school science reform pendulum again swung to other side.

The same thing happend at high school stage. The approach suggested for the middle stage was also suggested for high school stage (classes IX to X). Pointing out that "laws and theories to be gradually introduced and open-mindedness was to been couraged, the discipline approach was adopted in case of Physics and Chemistry and 'Group Approach' was adopted in case of Botany, Zoology, and Physiology (Life Sciences). This implementation indicated the gap between policy making and its implementation. The gap existed between policy making and its implementation even when both were evolved under same institution and in most cases supervised by the same persons. However, the model curricula repeated the vaccillations in school science policies. The policies enunciated appear to have a resemblance with the school science policies prevalent during the fifties and early sixties. In the Sixties new programmes were launched on the recommendations of Indian Parliamentary and Scientific Committee-IPSC (1963), UNESCO Planning Mission (1964), Education Commission (1964-66) and National Policy on Education (1968). These programmes were projected in Fourth and Fifth Five Year Plans. The approaches to school science education programmes which were found unsuitable by one group of educationists, committies or commissions were found to be reasonable during the period under review. The pendulum of school science education reform again swung to the otherside following the recommendations of the 'Model Curricula'. Thus it appears that there remained compromises both in making a school science education policy and in its execution for great majority of schools.

MAJOR FINDINGS

During the British period, though there were pious platitudes and inspiring recommendations for introducing science education even in primary classes, these recommendations, for one reason or the other, were not implemented. One can find vacillations, uncertainty and aimless compromise both in making a school science policy and in its execution for great majority of schools. Decisions/recommendations once made were countermanded a few years later. Apart from the Governmental efforts, Indian nationals took upon themselves the task of imparting school science education in their own way and tried to pick up the best from our scientific cultural heritage in order to correlate it with our glorious past but they, too, did not succeed much in their efforts. Thus, there appeared a little development in the area of school science education for the great majority of schools during the British period.

With the dawn of Independence a number of policy statements were made to tackle the problem of education, in general and science education, in particular, so as to keep pace with modern industrial societies. Substantial investments were made for meeting manpower requirements of a modernising society and for ensuring participation of the masses in developmental processes. Educational development was taken up seriously as an integrated element of social and economic planning. The expansion of elementary education was considered to be an important and priority task, Educational facilities were made available within a kilometre of walking distance for the primary stage and within a walking distance of three kilometers for the middle stage.

School science education was accorded high priority in planning. Special facilities were provided to train/orient science teachers to teach science effectively. Substantial investments were made in different aspects of school science education, such as strengthening of teacher training colleges and schools with laboratory and workshop equipment, providing science kits to lakhs of primary schools, inservice training of lakhs of primary and middle school teachers, provision of mobile laboratory vans, establishment of science training centres, provision for supervision, inservice training programmes of secondary school teachers (summer science institutes), out-of-class science activities—clubs, fairs exhibitions, state science museums, etc. These along with systematic work in the development of school science curriculum, syllabus, textbooks, guides, manuals, evaluation tools, equipment, audio-visual aids sought to ensure the availability of school science education of a quality and standard which compares favourably with advanced countries. An important development has been experimentation with different approaches of school science education and carrying out different projects—some started as a "brilliant one" and "incomparable project" having catalytic effect in enhancing the state's efforts and establishment of infrastructures both at the national and state levels for implementation of school science educational programmes involving such tasks as development of curricula, teacher training and try-outs in schools. These and other developments provided experience which can now be utilized for further progress.

Considerable efforts were made to achieve universalization of elementary school science in formal system and to achieve the comparative quality of science teaching in all schools. The instructional materials for science teaching prepared and made available could not be adopted/adapted satisfactorily in single-two-andthree-teacher schools which constituted 77.74 per cent of the schools in the country. It appears that suitable instructional materials for science teaching could not be developed according to the situations prevailing in the majority of schools of the country.

A major problem for the school science system appeared to be a lack of clear-cut, consistent, and effective science education policy both in its making as well as in its implementation for the great majority of schools. There appeared frequent major shifts in school science policy. The approaches to school science education found proper in the fifties were found wanting in the sixties and the approaches found reasonable in the sixties were found not so rational in the seventees. The approaches to school science enunciated in the seventies appeared to have resemblance with the school science policies prevalent during the fifties and the early sixties. The pendulum of school science education reform appeared to swing from one extreme to another within a period of ten years. None took notice of Sarabhai's observation that "education is a process which is not something which occurs in two or three or even four or five years; it is a process, which affects the whole generation and the generation is the time constant in which the educational process can be seen take effect".

School science education policy appeared to be bandied from one idea to another idea, from one recommendation to another, leading to vacillations in policy implementation, The ambiguity in policy decisions was also subjected to different interpretations at the implementation stage. There remained parallel and contending view points in school science education policy, the lines between and amongst were not clear.

There appeared a divergence between the priorities that the planners identified for the economic development and the priorities that the equcational planning decision-makers set for themselves. There also appeared a divergence amongst the views of the different agencies involved in the educational improvement of school science. Because of the absence of proper experimentation, there appeared a hiatus between the identified objectives of planned development and the decided educational programme priorities. Perhaps because of this hiatus between the planning priorities and the implementation priorities of school science programmes, it appears, that half-hearted efforts were put in and a clear-cut, consistent and effective school sciene education policy could not emerge.

Not only these, the non-uniformity of the school structure appeared to create difficulty in achieving the comparable quality of school science in all schools in the country. Had the school structure been uniform, efforts made at one place could be replicated elsewhere avoiding additional efforts.

Since Independence there had been a constant effort to institutionalize innovations, experiences of different programmes and to have a convergence about the policies. However, there appears a need for integrating various experiences to form an overall strategy of school science educational development and to formulate a clear-cut, consistent and effective science education policy and a national consensus on a programme of implementation.

APPENDIX A

SPECIMEN SYLLABUS FOR STANDARD I

(Note: Numbers in brackets show periods per year; each of 30 minutes)

Content	*Students' activities*	*Teaching suggestions*	*Equipments, Materials*
Living Things			
1. Common plants in the neighbourhood: (25)			
(a) Large trees and small trees.	(a) Nature rambles in the school garden and in the neighbourhood.		
(b) Parts of trees-stem, root, leaf, flower.	(b) Collection of different parts of trees leaves, flowers.	Classification of leaves on the basis of size and shape. Classification of flowers on the basis of size, shape, colour, smell.	Newspaper sheets, blotting paper sheets, threadand needle.

(*Contd.*)

(c) Trees are alive: they need water and food, sunshine and warmth.	(c) Germination of seeds on damp cloth and in pots. Care of individual plants, watering.	Teacher supplements by experiments the need of water, soil, sunshine and warmth for growth of plants. How plants die if deprived of water, food, sunshine and warmth.	Seeds, Cloth pieces, Cord for tying up, water, soil, a few small earthen pots, glass jars, or wide mouthed glass bottles or tumbler, black paper; cowdung, compost manure; ammonium sulphate.
2. Seeds of plants are scattered in different ways (10)	Nature-rambles, collection of seeds, pods of seeds, flying seeds and playing with them.	Teacher helps children to classify seeds on the basis of colour, size and shape.	Small earthen-vessel, match boxes or empty cigarette tins for keeping seeds.
3. Animals: They need water and food, make their homes, care for their young. (Observation of animal and bird behaviour and recognition) (20)	Nature rambles in the neighbourhood for observing the types of animal and bird visitors.	Rambles to be organised for observing seasonal changes.	
4. Personal cleanliness: cleaning of face, nails, teeth, nose, eyes, etc. (15)	(a) Cleanliness drill in the school. (b) An outing for bathing in a nearby stream, well or tank.	Teacher to supervise. This can be organised as a part of a picnic; demonstration by the teacher of proper cleanliness habits.	Oil, soap, combs, towels some food material.
5. Cleaning and beautifying the class-room (10)	Daily cleaning and dusting of the rooms and furniture.		

Earth and Universe			
1. Sunrise and sunset (a) Direction (b) Shadows (c) Usefulness of the sun (30)	(a) Finding prime directions from sunrise and sunset.	Teacher will help children to note the change in the length of shadows at different times of the day.	A straight stick, cord; improvised foot-ruler.
	(b) Observing the shadow of trees, buildings, etc. in relation to the direction of the sun.		
	(c) Observing the colour of the sky at sunrise and sunset.	A lesson or two about the sun to supplement observations of children: What we get from the sun?	A few pictures or illustrations about the sun.
2. Moon: Dark night, moonlit night, changing shapes of the moon. (25)	(a) Observation at night—Full moon, first quarter, new-moon, third quarter, etc.		
	(b) Making replicas of the shapes of the moon, twice a week on pieces ef paper, for a period of two continuous months.	To be done in winter months, teacher will help children in cutting out the shapes of the moon from paper and pasting them on cardboard.	Coloured paper, scissors, cardboard (wall space can also be used for pasting).
3. Weather observations: Rain Clouds	a) Description of cloud forms	Observation work of the child to be supplemented by	

(Contd)

		topic lessons.	
Hot and cool days Wind and breeze (40)	(b) Finding direction of winds by dropping bits of paper or dust.		
	(c) Finding direction of winds by observing kites, smoke, toy baloons, seeds.		Balloons, kites
	(d) A ramble in the country after a shower.	Teacher will make children observe the changes caused by rains in the surroundings, Ramble will be a small scale geographical lesson.	
4. Sources of water in the locality, clean and dirty water (25)	(a) A ramble to find out different sources of water in the locality. (b) Collection of clear and muddy water.	Two rambles, one before and another after a shower.	Small buckets for storing water collected from different sources, glue to put lables on them.

Taradevi Seminar, (pp. 34-36)

Total No. of periods: 200

APPENDIX B

TOPICS FOR GENERAL SCIENCE SYLLABUS

Units Based on Environment Centred Topics

Unit I : The atmosphere
Unit II : Water, a vital need of life.
Unit III : The earth surface (Geoeconomic and Physical study)
Unit IV : Fire and heat
Unit V : Effects of heating and cooling on air and water
Unit VI : Study of light
Unit VII : Civilization and the use of metals
Unit VIII: : Work and energy (the occupations of man)
Unit IX : Problems of transport and communication
Unit X : Plants and animals in relation to life
Unit XI : The study of the Body Machine
Unit XII : Understanding ourselves
Unit XIII : Science and Philosophy of life (including development of scientific ideas in relation to social philosophy), time chart and case histories.
(Taradevi Seminar, p. 39)

Units Based on Life Centred Topics

Unit I : World that Science has built
Unit II : The Air we breathe
Unit III : The water we use
Unit IV : The food we eat

Unit V : How Man gets his food
Unit VI : The Clothes we wear
Unit VII : The Homes we live in
Unit VIII : The Machines we use
Unit IX : The Power we work with
Unit X : Protection from Disease
Unit XI : Our Biological resources
Unit XII : Our Mineral resources
Unit XIII : Means of Transport
Unit XIV : How we communicate with the world
Unit XV : The Universe we live in
Unit XVI : Story of Life
Unit XVII : How to be yourself

(Taradevi Seminar, p. 39)

Units Based on Life and Environment Centred Topics

Unit I : The world that science has built
Unit II : Your body machine and how it works
Unit III : Health to you
Unit IV : Using biological resources for better living
Unit V : Using mineral resources for better living
Unit VI : Energy and machines for the world of tomorrow
Unit VII : Time, measurement and mass production
Unit VIII : The weather and what we can do about it
Unit IX : Astronomy: (a) The solar system in which we live
(b) Billions of stars and other universes

Unit X : Science for our homes
A—Heating our homes
B—Lighting our homes
C—Electronics in the home
D—Sound in the home
E—Science and people

(Taradevi Seminar, pp. 39-40)

APPENDIX C

TOPICS FOR WORKING PAPERS-PREPARED BY UNESCO

1. Syllabus in General Science and Mathematics.
2. Syllabus in Physics.
3. Syllabus in Chemistry.
4. Syllabus in General Science—Unit I elaborated.
5. Equipment for General Science.
6. Equipment for Mathematics.
7. Equipment for Physics.
8. Equipment for Chemistry.
9. Equipment for Biology.
10. Description and use of the apparatus designed by UNESCO for school laboratories.
11. Blue-prints of the apparatus designed by UNESCO
12. Demonstrations and Experiments with UNESCO designed apparatus—General Science.
13. Demonstrations and Experiments with UNESCO designed apparatus—Physics.
14. Syllabus and Equipment for Teaching Elementary Science for Primary Schools.
15. A Handbook for Science Clubs.

INFORMATION PAPERS PREPARED BY UNESCO

1. The Science Fair is easy—if you let the students to do it.

2. Science Education, Research and the Class room Teacher.
3. Children's Books enrich Elementary Science.
4. Curriculum changes needed because of our times.
5. Conspiring to inspire through the Teaching of Science.
6. Science Teaching and then Laboratory.
7. The Use of the Sponsored Films in Teaching Biology.
8. A New Building: Elementary Science Implications.
9. Method in Science Teaching,
10. Integration of Science with other subjects.
11. Teaching of General Science.
12. Improving Science Teaching.

(Taradevi Seminar, pp. 10-11).

APPENDIX D

THE MAIN RECOMMENDATIONS OF UNESCO PLANNING MISSION'S REPORT

1. A programme of Science Education for all the students from class I to X and specialised programme for those offering the Science stream up to class XI.
2. Deepening of the existing syllabi and incorporating modern developments in respective sciences. Detailed draft syllabi have been suggested for all subjects in three stages I-V, VI-VIII and IX to XI.
3. General Science teaching up to class V and then separate disciplines of Biology, Physics and Chemistry from class VI onwards.
4. The guiding principle of Science education be a judicious combination of theory and practical work both demonstration and individual experimentation.
5. Polytechnical world outlook should be developed through Science education by including suitable topics in Science subjects.
6. Development of method guides for the use of teachers.
7. Preparation of textbooks on certain suggested principles and translation of some Russian textbooks.
8. Setting up of number of University special mathematics boarding schools and boarding schools of Science for talented pupils.
9. Combined study room both for practical and lecture work for each Science subject.
10. Preparation of compulsory norms and lists of teaching equipments.

11. A Programme of work for the Central Science Workshop to produce proto-types of Science equipment for schools.

12. Establishment of a museum of teaching equipment.

13. An emphasis on Science content in a teacher training school syllabus so that a graduate from there should have general education equal to the higher secondary school level in Science and pedagogical qualifications.

14. The present one-year teacher training colleges programme may continue for another decade with suggested changes in its curriculum and improvement of staff. There should be a unified programme in all the training colleges.

15. Two schemes of training for M. Ed. course.

16. A revised programme for the Regional Colleges by rearranging the syllabus and time schedule.

17. The programme of the Regional Colleges can become the major means of training Science & Mathematics teachers and hence their number should be increased. It is desirable that the total enrolment in such colleges be kept at 1,000 to make it an economic proposition and to provide specialists in all the major subjects.

18. A project of training teachers through correspondence Education and in-service training centres through Universities and Regional Colleges to meet the large demand of qualified Science Teachers in future years.

19. Increase in the number of Extension Service Centres.

20. A plan for Research in Science Education through Department of Science Education, National Council of Educational Research and Training as the main coordinating agency.

21. To increase by 1966 two-fold the enrolment of pupils in

Science stream of higher secondary schools as compared to the 1963 enrolment.

22. A sequence and time of implementation of the recommendations.

23. A phased programme of deputing experts from USSR to work with Indian workers and training of Indian workers in USSR.

(Central Advisory Board of Education (CABE)-Proceedings of the Thirty First Meeting October, 1964, Annexure-X).

APPENDIX E

INSTRUCTIONAL MATERIALS PRODUCED UNDER UNESCO-UNICEF PROJECT (S.E.P.)

(Middle and Secondary Stages-Upto 1972-73)

I. Syllabi

1. Syllabus for Science & Mathematics for middle stage.
2. Syllabus for Science & Mathematics for secondary stage.
3. Curriculum Guide, Physics, Part I.
4. Curriculum Guide, Biology Part I.
5. Curriculum Guide, Arithmetic-Algebra Part I.
6. Curriculum Guide, Geometry Part I.
7. Curriculum Materials for pre-service teacher training (Draft manuscript).

II. Textbooks for the middle stage	*Processing Method*
1. Physics Part I	7 editions
2. Physics Part II	6 editions
3. Physics Part III	5 editions
4. Biology Part I	7 editions
5. Biology Part II	5 editions
6. Biology Part III	4 editions
7. Chemistry Part I	5 editions
8. Chemistry Part II	5 editions
9. Arithmetic-Algebra Part I	5 editions

10. Arithmetic-Algebra Part II	5 editions
11. Arithmetic-Algebra Part III	3 editions
12. Geometry Part I	7 editions
13. Geometry Part II	4 editions
14. Geometry Part III	3 editions

III. Textbooks for the Secondary Stage

1. Physics Part IV	in press
2. Physics Part V	manuscript
3. Physics Part VI	synopsis
4. Chemistry Part III	in press
5. Chemistry Part IV	manuscript
6. Chemistry Part V	synopsis
7. Biology Part IV	manuscript
8. Biology Part V	manuscript
9. Biology Part VI	synopsis
10. Mathematics Part IV	manuscript
11. Mathematics Part V	manuscript
12. Mathematics Part VI	synopsis

IV. Kits of Equipment	*Stage of development*
1. Physics demonstration Kit No. 1	Production
2. Physics demonstration Kit No. 2	-do-
3. Physics demonstration Kit No. 3	-do-
4. Physics Pupils' Kit No. 1	Prototype
5. Physics pupils' Kit No. 2	-do-
6. Physics pupils' Kit No. 3	Prototype
7. Biology Kit No. 1	Production

8. Biology demonstration kit	-do-
9. Chemistry Kit No. 1	Prototype
10. Chemistry demonstration kit	Production
11. Chemistry pupils' kit	-do-
12. Mathematics demonstration kit	Prototype
13. Mathematics pupils' kit	-do-
14. Working drawing of physics Kit No. 1,2,3.	

V. Guide Materials

1. Curriculum Guide Physics Part I.
2. Curriculum Guide Biology Part I.
3. Curriculum Guide Arithmetic-Algebra Part I.
4. Curriculum Guide Geometry Part I.
5. Teachers Guide Physics Part I.
6. Teachers Guide Physics Part II.
7. Teachers Guide Physics Part III.
8. Teachers Guide Biology Part I.
9. Teachers Guide Biology Part II.
10. Teachers Guide Chemistry Part I.
11. Teachers Guide Chemistry Part II.
12. Teachers Guide Arithmetic-Algebra Part I.
13. Teachers Guide Arithmetic-Algebra Part II.
14. Teachers Guide Arithmetic-Algebra Part III.
15. Teachers Guide Geometry Part I.
16. Teachers Guide Geometry Part II.
17. Teachers Manual Physics Part III.
18. Kit Guide Physics Part I, Part II, Part III.

19. Kit Guide Biology
20. Kit Guide Chemistry
21. Demonstration Cards Part I Physics
    Part II Physics-manuscript
    Part III Physics-manuscript
22. Guide for use of equipment supplied under SSST Project-1972.
23. Teachers Guide Physics Part IV manuscript
24. Improvising Science Teaching Kits.

VI. Audio-Visual Aids

Films-

1. Teaching Physics Today
2. Energy and its forms
3. Know Your Biology Kit
    for Part I-Botany
    for Part II-Human Physiology

Sets of Slides

1. Teaching Physics Today with accompanying brochure.
2. Physics Part I
3. Physics Part II
4. Physics Part III
5. Know our Biology Kit (Human Physiology)
6. Diversity of Plants.

Filmstrips

1. Pressure in Fluids
2. Symmetry

Pictorial Packages

1. Know Your Biology Kit

2. Mathematics Kit

VII. Evaluation Materials

1. Textbook evaluation questionnaires:
    Physics Part I and II
    Chemistry Part I
    Biology Part I
2. Kit evaluation questionnaires:
    Physics Part I
3. Evaluation manual (under preparation)
4. Reports of workshops on evaluation:
    Physics, Biology, Chemistry, Mathematics.
5. Bank of questionnaires (Under preparation)

VIII. Teacher-training

1. Experimental Methods of Teaching Chemistry - Cyclostyled
2. Activity Learning of Science Process - -do-
3. Curriculum Materials for pre-service Teacher-Training - Draft

(Based on Tamarin's Report and Annual Reports of NCERT, cited in reference.)

APPENDIX F

POSITION OF CURRICULUM MATERIALS DEVELOPED BY THE STUDY GROUPS IN PHYSICS, CHEMISTRY, BIOLOGY, AND MATHEMATICS AS ON 31ST MARCH, 1972

Curriculum materials printed	*Curriculum materials in press*	*Curriculum materials ready for printing*	*Curriculum materials being developed*
Physics			
Textbook I and Book II	Textbook III	—	Textbook IV, V and VI Demonstration kit to go with Book I—developed Demonstration kit to go with Book II—in press
Chemistry			
Textbook, Class 6 and 7 Teachers Guide for Class 6 Teachers Guide for Class 7. Lab. Manual Class 6. Lab. Manual Class 7. Lab. Manual Class 8. Textbook Class 8.	Teachers Guide Class VIII	Textbook Class IX Lab. Manual for classes IX and X.	Teacher's Guide for class IX and X

Biology			
Book I, II and III Teachers Guide for Book I, II and III.	—	Textbook IV, V and VI,	— Teachers' Guide for Book IV, V and VI.
Mathematics			
Geometry Book I, II and III. Algebra Book I and II. Teachers Guide for Geometry Book I. Teachers Guide for Algebra Book I. Handbook for Teachers Classes I and II.	Teachers' Guide for Geometry Book II and III. Teachers Guide for Algebra Book II and III.	Algebra Book III. Textbook for High School S. I and S. II.	Textbook S. III. Teachers Guide for S.I., S. II and S. III.
Supplementary Reading Materials			
2 titles	6 titles	3 titles	22 more titles under preparation.

(Based on the NCERT Annual Reports and paper presented by Department of Science in Faculty Meetings).

INDEX

Abbot, A., 87,252
Abbot-Wood Report 71-72
Abdullah, Sheikh, 7
Adams, John, *Sir*, 260
Agra, 83
Aiya, S.V.C., 201
Ajmer, 18
Aligarh Muslim University, 13
Allahabad, 98
All India Council for Secondary Education, 120-121, 126, 131, 135 141
All India Council for Technical Education, 94-95
All India Federation of Education Associations, 101
All India Science Teacher's Association, 144,205
American Schools, 210
American experts, 151, 256
Amhert, Lord., 38
Amritsar, 18
Annual Plans, 188
Apparatus, 149
Archeological Survey of India, 47
Aryabhatta, 7
Asiatic Society, 35,43
Assam, 144
Atomic Energy Commission, 9
Attreya, B.D., 30
Azizullah, Sheikh, 7

Baderia, G.S., 212
Baudhayana, 7
Basic Education Scheme, 73-77, 252-253, 255, 256
Battle of Plassey, 34
Belgaun, 14
Benaras, 38, 40
Benaras Sanskrit College, 35
National Council of Education, (Bengal) 251
Bentinck, Lord william, 41-42
Bernal, J.D., 7, 10
Bhargava, K.D., 37-38, 48
Bhargava, P.M., 236
Bingham, N.E., 117
Bloom, B.S., 121
Broad Fields Curriculm, 118-119
Bombay, 14, 47, 52, 68
University, 53
Bose, A.N., 13, 20, 229, 231
Bose, D.M., 35, 40, 42, 45, 55
Brahmgupta, 7
Brioukhanov, A. V., 198
Bryce, D. Rev., 37

Calcutta, 7, 34-35, 38, 43, 47
  Madarasha, 7, 34-35, 38
  University, 59
Calcutta University, Commission, 8, 65-68, 117-119, 162
Canada, 137, 138
Central Advisory Board of Edu-

cation 27, 71, 95, 105, 110-111, 139, 142, 190-191, 196, 258
Cenntral Board of Science Education, 235
Central Bureau of Textbook Research, 141
Central Science Club, 143
Centre for Educational Development Overseas Team, 202-204, 213, 261
Centres scheme, 148
Chandra, B., 44
Chowdhury, S.M.M. Rahman, 34
Christic, John, 110
Committee on Curriculum of Basic Education, 95
Committee of Members of Parliament on Education, 1967, 190
Committee on Emotional Integration 1962, 142, 161-162
Concept Teaching Approach, 150, 211, 257
Conference of Education Ministers 1967, 190
Corly, Stephen M., 142
Cremin, A., 118
Croft, Sir Alfred, 53
Crowther Report, 166
Curricula, 172, 178
  Education Commission of, 196
    recommendation, 180-182
Curriculum, 210-211, 250
  Educational Board for, 236
    IPSC's recommendation for on, 166-168
    National Conference, on, 225-227
Cirriculum Development Committee, 230

Dalhousi, Lord, 43
Delhi, 71, 121, 144
Deo, Raja Radha Kanta, 38
Desai, D.B., 17
Dhanvantri, 7
Directorate of Extension Programme for Secondary Education, 135, 141, 142, 256-257
Discipline approach, 182, 202
  Structure of, 210
Domestic science, 159
Doraiswamy, S., 230
Ducan, Jonathan, 35

East, Edward Hyde, 38
East India Company, 34
Editorial Boards, 235-236, 264
Editorial Board for Integrated Science Curriculum, 236
Education
  fund allocation for, 195
  in Third Plan, 147
  in Fourth Plan, 195
reforms suggested by Education Commission, 176-177
  Structure of, 178-179
Education Commission of 1964-1966, 175-182, 184-185, 205, 227, 233, 235, 237, 259-260
Educational development, British Indian, 250-255
Elementary school, 203
Elphinistone College, 40
Elphinstone, Mountstuart, 37
England see UK.
English medium schools, 251
Environmental studies, 227-229, 234, 263
  seminar on, 228
Europe, 7, 34, 54
Expenditure, 191
Experimental teaching, 198
Extension service Centre, 160
Evans, R.M., 228, 233

Emrest, George, 43

Five Year Plans
  First, 26, 38, 101, 108, 121, 130, 254
  Second, 128, 129, 130, 139, 143, 255-256
  Third, 145-149, 256
  aims of, 146
    and agricultural production, 146
  Fourth, 191, 195-196, 260
  Sixth, 2, 5
Ford Foundation, 123
Foreign documents, 166
Fourth All India Educational Survey, 25

Gandhi, Indira, 5, 228
Gandhi, M. K., 72, 225
  on Education system, 72-74
General Science approach, 159-160 173, 182, 233-234
Ghosh, B., 16
Ghosal, T., 16
Goa, 33
Government Central Pedagogical Institute, 98-99
Grant, Charles, 36
Great Trignometrical Survey, 43
Gregory, J.W., 66
Gujarat, 144
Gupta, L. N., 16
Gupta, A.P., 9

Hailes, Little, 68
Hampson, George, 123
Harap, Henry, 137
Hardinge, Lord, 42, 60
Hartog Committee, 69-70, 252
  recommendations of, 80-82
Hastings, Warren, 34
High School, 203
  science teaching in, 237-238
Hindu College (Calcutta), 39
Hindustani Talimi Sangh, 97-98
Hoshangabad, 9
House of Commons, 36
Hunter, William, 35
Hussain, Zakir, 95
Huxlly, T.H., 47

India, 1, 23, 33, 113, 138
Indian Association for Cultivation of Science, 47
Indian Botanic Garden, 35
Indian Education Commission (1882-83), 8, 48-51, 162, 203, 251
Indian Education Policy (1904), 57-58, 62
Indian National Congress, 79
Indian Parliamentary and Scientific Committee (IPSC), 3, 162-169, 209, 257-258
  criticism of, 167-168
  purpose of, 163
  recommendations of, 165-168, 182-183
Indian Statutory Commission, Auxiliary Committee of, 69-70, 80
Indian University Commission (1902), 57
Indian Yearbook of Education, 16
Industrial Policy Resolution (1956), 129
International Study Conference (1956), 136
Islam, 7

Japan, 2
Johns, W., 35
Joint Venture, 199
Joshi, A.C., 122-123, 124, 135
Joshi, M.S., 121
Kabir, Humayun, 94, 144
Kelkar, S.V., 14

Kerala, 138, 143
Kirkpatrick, P., 170
Koroley, F., 201
Kothari, D.S., 1, 144, 247
Kothari Commission, 184-185, 175-182, 225
Kothari Coordinating Committee, 206

Laboratory, 193
Liddle, C.S., 123

Macaulay, Lord., 41
Machenzie, Gorden, 123
Madras, 35, 40, 47, 57, 62
Madhya Pradesh, 143
Magna Charta, 45
Maharashtra, 143-144
Mahalanobis, P.C., 4, 10, 27
Mahalanobis Science Committee, 157-159
Martin, George, 228
Mason, Robert, E., 211, 216
Materials,
  development of, 223-224
Medhatihi, 7
Medium of instructions, 251
Menon, M.B., 14
Mikelson, S.L., 135
Middle Schools, 203
  science education and, 234-237
Minto, Lord, 37
Mishra, A.K., 23
Model Curricula, 240, 263
Montagu—Chelmsford Reforms, 68
Mudaliar, A.L., 110
Mukherjee, M.D., 59
Mukherjee, U., 59
Munjajjim, Mulla Farid. 7
Munro, Thomas, 40

Naidu, R., 135
Naik, J. P., 57, 58, 62, 69, 72, 175
Narullah, S, 62
Natarajan, S., 40
Nathan, R., 56
National Basic Education System
  science training, 138-141, 149
National Council of Educational Research and Training (NCERT), 4, 17, 25, 61, 197, 212, 214, 223, 224-226, 229-231, 234, 236, 259, 262, 264
National Education Movement (1905), 59
National Institute of Basic Education, 130, 140-141
National Planning Committee (1938), 78, 79, 86, 96, 252, 258
National policy, 190-191, 225-234, 260-261
National Seminar on Science Teaching, 122-128
  recommendations of, 127
Nehru, Jawahar Lal, 3, 226
  on science, 3-4
  on education, 94-95
Non-cooperation Movement, 77
North Western Frontier Provinces (NWFP), 52
Nuffiled Project UK, 208

Oldhams, Thomas, 43
Orte, Garcie-da, 33
Oxford, 110

Package programme, 200
Panels and Editorial Boards, 209
Parulekar, R. V., 61
Patel (I.B.) Review Committee, 231-232, 263
Patole, N. K., 15-16
Perishkin, A. B., 202
Physical Science Committee (PSSC), 258, 262
Pilot project, 197-202, 258
Plan outlay, 195
Planning Commission, 2, 129
Planning Group on Education 1968, 191-195, 260
Poona University, 13
Post War Educational Development (1944), 79-80, 83-84

Price, Powell, 78
Primary Schools,
  science education of, 196-197, 227-234
Primary and Secondary Reorganization Committee (1938-39), 98
Prisep, H. T., 41
Punjab, 71, 143
Punjab University, 57

Radha Krishnan Committee
See University Education Commission

Rais Ahmed, 236-237
Rais Ahmed Expert Group, 225
Raina, T. N., 18
Review committee, 212
Rajasthan, 143
Rajput, J. S. 18-19
Resolution on Indian Education Policy (1913), 60, 62, 65
Richy, J. A., 43-45, 63
Ripon, Lord, 51
Roy, Raja Ram Mohan, 38-39
Roy, S., 17, 19
Royal Botanic Garden, 35
Rozario, Rexd, 9
Rural schools,
  science teaching in, 251-252
Russel, Bertrand, 166
Sadler Commission see, Calcutta University Commission
Sampurnand Committee 1962, 145, 161-162, 171
Sapru, Tej Bahadur, 83
Sargent, John, 72, 84, 95, 140
Sargent plan
  see post war Educational Development
Sarvodya, 101
School Science in British India, 250-255
  education Commission's recomendedations and, 175-182, 184-185
  approaches to, 196-197
  improvement steps for, 194-195
  IPSC's recommendations on, 166-167
  for primary classes, 179
  for higher level, 179-180
  Mahalanobis committee's recommendations, 157-159
  pattern of, 165
  pilot projecy for, 197-204
  purposes of, 163-164, 177, 250
  study group project for, 204-208
  Summer Science Institutes for 208-212
  SEP programmes for, 222-227
  teaching problems of, 159-162
  UNESCO Mission (1964) and, 169-175, 183-184
Schooling patterns, 162
Science
  and national prosperity, 1-9
  and technology, 1-3
  meaning of
Science club, 193
Science Courses, 171-172, 201-202, 252
  in Elementary Classes, 68, 69, 124-126
  in Middle schools, 51-53
  in High Schools, 53-56
  in secondary schools, 62-65, 80-82
  IPSC's recommendations, 165-166, 168
  shortcoming in, 173
Science Education
  during East India Company, 36-56
  during 1859-1900, 46-65
  during 1920-47, 68
  during 1947-52, 94-107
  during 1952-57, 109-132
  during 1957-62, 135-144
  during 62-67
  during 67-72
  during 72-77
  Amrican influence on, 116-117

  in Indian Schools, 6-8
  and scientific tamper, 4-5
  objectives of, 227, 237
  status of, 170-171
Science Education Commission, 138-139
Science Education Programme, (SEP), 222-227, 239
  implementation of, 222
  three phases of, 222
Scienc Kits, 224
Science Mobile Laboratories, 200
Scientific Policy Resolution (1958), 1, 3, 136-139, 143, 145, 150, 255-256
Secondary education,
  in third plan, 147-149
Secondary Education Commission, 26, 110-115, 149-151, 162, 171, 254, 255-257
Sethna, H. N., 9, 24
Shapovalenco, S. C., 169
Shapovalenco Mission of. 1964, 169-175
Sharp, H., 33-38, 41-42
Sharma, H. L., 18
Shirazi, Mir Fathullah, 7
Shroeder, Frak, 135
Shukla, 117, 120, 128, 140
Shukla Committee, 225
Simla, 123
Singh, R. P, 77
Singh, Raja Roy, 26, 201
Singhal, R. P., 225
Six national programme, 191
Srivastva, H. S., 232
SST Projects, 161, 197, 201-204, 258-259
State Science Institutes, 200, 238-239
Study Group Project, 204-208, 214, 262
Subbrayappa, B. V., 34-35, 55
Summer Science Institutes, 208-212, objectives of, 209-210
Taba, Hilda, 210
Tagore, Rabindra Nath, 226
Tamarin, 198, 200
Taradevi Seminar, 231, 255
Teacher training, 148, 160-161, 198-199
  Fourth Five year plan and, 195
  science material for, 200-201
Teachers' qualifications, 193
Teaching equipments' 171
Teaching materials, 200
Teaching methodology, 171
Technical cooperative mission, 120
Ten-plus-two pattern, 225-227
Terry, Mark., 232
Textbooks, 171-172, 201-202
  and curriculla development of, 235-236
Thomas, D. H. W.. 228
Thomson, C. Rev. 37
Trivandrum, 18

Umasvati, 7
Union of Soviet Socialist Rupublics (USSR), 60, 78, 112, 144, 258
  experts of, 261-262
  science teaching in, 167, 173-174, 252
  syllabus in, 201-202
United Kingdom, 15, 110, 137-138
environmental studies in, 228
United Nations Educational, Scientific and Cultural Organization (UNESCO), 8, 29, 60, 125, 127, 136-137, 161
  planning mission (1964), of 169-175, 183-184, 197-198, 202, 205, 212-213, 235, 258-260
  and SST projects, 197-198, 202-204
  and SEP Programme, 222-227, 239
  and UNICEF Projects, 199-202, 213-219, 238, 261-262
UN Conference on the Human Environment, 1972,228
United Nations Development Pro-

gaamme, (UNDP), 161, 169, 197 198
United Provinces Unemployment Committee
  See Sapru Committee
United States of America (USA), 15, 110, 116, 137-138
  broad field curriculum in, 101-102
University Education Commission (1948-49), 8, 99-101, 162-164, 182, 255
University Education Report (1948), 26
University Grants Commission, 144, 210
University Chicago, 121
Uttar Prad esh, 71, 82-83, 98, 153-144

Vaidya, N., 9, 18
Vakil, K.S., 40
Varahmihir, 7
Veerappa, N.S., 15

Weilich, Nathaniel, 43
Wanchoo, V.N., 18,239
Ward, C.F.. 123
Wardha Education Conference (1937), 74
West Bengal, 143
Wilson, H.H., 39
Williams, Kenneth Rost, 116
Wood, S.H., 87,252
Work Shop,
  for primary science, 229-230
Work experience, 177-178
World War-II, 77

Yadav, M.S., 14
Young, A.J., 233

Zakir Hussain Committee, 73-74, 96
Zrerev, 201

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A science teacher to start with, Dr. Sharma taught Physics at University level and was Head of the Physics Department in a degree college before joining NCERT in 1966.

Dr. Sharma has worked on UNESCO-UNICEF assisted projects-SSST, SEP, PECR, DACEP and working with Russian, American and British Science Education experts contributed to curricular and training materials. Summer Science Institutes Science Study Groups and Editorial Boards were resource supplied by his capabilities. Dr. Sharma has authored, co-authored and edited a large number of books published by NCERT and other organisations.

Some of his researches are : "An Investigation into Primary Level Teacher's Understanding of the Science Curriculum of UNESCO-UNICEF Assisted Scheme in Delhi", "Survey of Researches in Science and Mathematics Education in India," "Mobile Science Laboratory Van Project" "A Survey of NCERT's Experimental Non-Formal Education Centres (1978-82)", "Identification of Various Approaches/Practices of Non-formal Education". He has also to his credit more than 50 research papers, articles and literary essays on Scientific Topics published in National International Journals, Newspapers and in Hindi textbooks.

Dr. Sharma has participated, acted as resource person and has organised a large number of programmes, at National and International level. He represented India on a UNESCO Study Group Meet on Alternative Educational Delivery System for Rural Poor with Focus on Science and Technology Education, Manila (Philipines).

Since 1978, Dr. Sharma has been developing curricular, training and science teaching materials and organising training of Non-Formal Education Functionaries of the states and the voluntary organisations for the implementation of NFE Scheme sponsored by Ministry of HRD, Govt. of India.

He is associated with a number of professional organisations. Working as Secretary and Coordinator Academic Programmes he is editor of Vigyan Shikshak—The Science Teacher, a quarterly Journal of AISTA.

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